Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

766Fi
p. 2

January 1967

Vol. 28, No. 1

FIRE CONTROL NOTES

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

JUN 21 1967

CURRENT SERIAL RECORDS

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Page

3 The Carolina Blowup
Keith A. Argow

4 Fuel-Breaks—Effective Aids, Not Cure-Alls
James L. Murphy, Lisle R. Green, and Jay R. Bentley

6 A New Approach To Fireline Construction
R. W. Johansen

7 Helicopters and Firemen—The Ruby Fire Team
Fred W. Tyler

Page

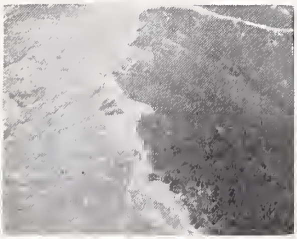
8 Developing Foam With An Aerial Tanker
J. W. Colquitt and R. W. Johansen

9 Keys To A Successful Air-Attack Program
E. F. McNamara

12 Fighting Fire With High-Pressure Air Jets . . . Some Preliminary Results
Dean L. Dibble and James B. Davis

14 Fire Weather Telemetry
Frank E. Lewis

16 Marking Fire Handtool Handles
Region 10, U.S. Forest Service



COVER—The fuel-break shown stopped the Horse Fire on the Mendocino National Forest (Calif.). See related story on page 4.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

THE CAROLINA BLOWUP[1]

Keith A. Argow, *Instructor,*
School of Forestry, North Carolina State College

April 1, 1966, was not a day for April Fool jokes in the coastal pinelands of North and South Carolina. It was an explosive fire day unrivaled in recent times. In those hot 24 hours, 72,000 acres in the two States were burned, 3,000 acres per hour. It was a Black Friday for more than 50 families whose homes were destroyed.

A news release from the South Carolina State Forester's office in Columbia summed up the situation: "The driest March in ten years created the forest fire danger that exploded on Friday, April 1st, into an almost uncontrollable situation. In three days, Friday, Saturday, and Sunday, 480 wildfires burned 70,000 acres bringing the total fire loss since July 1965 to 4,800 wildfires burning 120,000 acres of woodland."

This was the greatest loss in 11 years. Before the rains came on April 4, the forest area burned in the two Carolinas during this explosive period reached 144,000 acres. The largest fires were in the coastal pinelands, but damage was not limited to that area as numerous fires sprang up across the Piedmont.

The conflagration came as no real surprise to forest protection personnel. A very dry March had followed a dry winter.

On March 30, a meteorologist from the U. S. Forest Service's Southeastern Forest Fire Laboratory in Macon, Ga., telephoned the State forestry headquarters in Raleigh, N.C., and Columbia, outlining the full danger of the unstable weather conditions. Wind and pressure patterns such as these had come to the South before. They usually meant trouble on going fires.

The North Carolina State Forester immediately cancelled all burning permits and prohibited use of fire near woods. Yet even with this preventive measure, fire crews in the Tarheel State fought 273 wildfires covering 18,000 acres on the last 2 days of March.

In South Carolina on the same day, the Forestry Commission closed all State parks to public use. On the evening of March 31, the governor issued a proclamation prohibiting the use of fire adjacent to woodlands—the first time this had ever been done. (The authority was provided in a law passed after the disastrous 1954-55 fire season, when 7,000 fires burned 159,000 acres.)

APRIL 1

April 1 dawned clear and windy. The 10 a.m. report from Jones Lake tower on North Carolina's Bladen Lakes State Forest showed a high spread index, fuel moisture of 6 percent, and a steady wind of 18 miles per hour from the southwest.

By early afternoon rural residents and travelers in the Carolinas knew there was a serious fire situation. They didn't have to be told over the radio or see it in the news. They could smell the smoke and feel it burn their eyes.

The steady southwest winds were flowing between two areas of high pressure. One of the systems had recently passed out into the Atlantic. The second, a fast-moving cold front, was coming in from the Mississippi Valley. At 7 a.m. the leading edge was over the Great Smoky Mountains. By 1 p.m. it was in the Piedmont crossing over Charlotte and Winston-Salem. That evening it reached the Atlantic coast, bringing thunderstorms to Wilmington, N.C.

As the front hit, prevailing winds were pushed eastward by the strong winds within the system. This meant a 90-degree wind change as it passed. Fires that had made a narrow run to the northeast quickly turned southeast, their long flanks becoming new wide heads.

THE AMMON FIRE

One of the blazes that got the most publicity threatened the little town of Ammon, N.C., for 2 days and blackened 17,000 acres around it. The smoke was first reported at 1:30 p.m. on April 1. Rumor was that someone had been burning off an area to improve duck hunting, but no one was quite sure who it was.

Forty minutes later a forestry truck on patrol radioed that a second fire was coming out to the highway from nearby Black Lake. Crews just completing control lines on the White Oak fire only 15 miles away rushed to both new blazes.

Reconnaissance aircraft swung over from the large Newton Crossroads fire a scant 20 miles eastward and advised ground crews on the course of the flames and the best control action.

The fire towers, now nearly all socked in by smoke, relayed urgent radio messages between headquarters and the men on the firelines. "Fire

(Continued on page 15)

---

[1] Adapted from American Forests. July 1966.

FUEL-BREAKS—EFFECTIVE AIDS, NOT CURE-ALLS

JAMES L. MURPHY, LISLE R. GREEN, and JAY R. BENTLEY,[1]
Pacific Southwest Forest and Range Experiment Station

"This fire hit the ridge and kept right on going—it didn't even know the fuel-break was there." Or: "That fuel-break sure didn't do what it was built for—we wasted a lot of money and time building it." Or: "Fire will spread faster in tall grass on a fuel-break than in the brush." Or: "We don't need to worry about that side of the fire—there's a fuel-break up there." Such remarks have long been made and will continue to be made. Obviously, all firefighters do not understand the purposes and limitations of fuel-breaks, but strategically placed fuel-breaks help reduce the conflagration or fire disaster problem.

DEFINITION OF A FUEL-BREAK

A fuel-break is a strip of land on which the primary fuel, usually brush (fig. 1) or timber (fig. 2), has been permanently converted to a lighter, less dense fuel type to facilitate fire control. As prescribed by an interagency committee (Anonymous 1963)[2], fuel-breaks on ridgetops, in valleys, and along roads and wide benches are at least 200 feet wide. A firebreak—a road or other strip with exposed mineral soil—is often within the fuel-break.

A fuel-break may be built to help protect a single campground or community, or a connected network may be constructed to safeguard large wildland areas.

PURPOSE OF FUEL-BREAKS

1. Fuel-breaks break up the continuity of heavy fuels, and if the fuel-break system is dense enough, they help firefighters prevent fires from reaching and maintaining high-energy output levels. Resistance to control is less on fuel-breaks, and retardants dropped from aerial tankers may be more effective.

2. Fuel-breaks are permanent preattack installations, and when they are well located and constructed, they are effective in firefighting. They provide access for crews, ground tankers, and other vehicles. Thus, a fireman can backfire while *he* is the "boss"—not when the fire is.

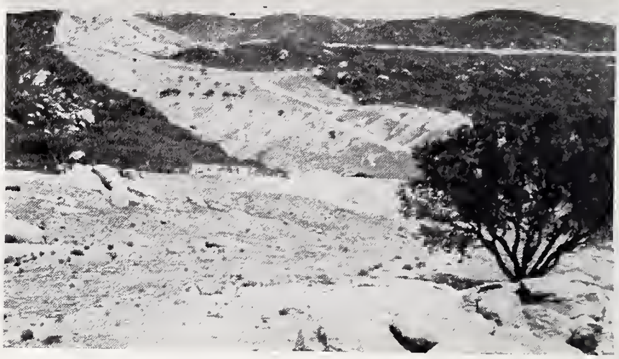


Figure 1.—Fuel-break in southern California brush.

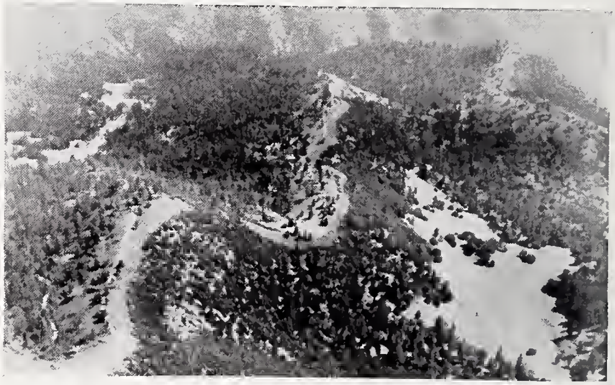


Figure 2.—Fuel-break in Sierra-Nevada mixed conifer type, in central California.

3. Fuel-break systems provide defense in depth. The first objective of an attack is to stop the fire in place. Subsequent strategy is directed by current fuel and fire behavior, but the fuel-break becomes important in fire-suppression strategy. If the fire jumps, fire control forces can be regrouped and redeployed until the fire can be held. Meanwhile, under most burning conditions, the flanks and rear of fires can be held at fuel-breaks. Because fuel-break systems improve the chances of fire control forces controlling fires during the first burning period, "control by 10 a.m." becomes a realistic objective, even for conflagration fires.

4. Fuel-breaks used as line locations tend to reduce mopup and patrol costs after a fire is controlled. They provide safer access for firefighters. And the lighter fuels on the breaks do not hold fire tenaciously or as long. Consequently, the problem of high costs due to slow, tedious mopup and long, intensive patrols can be alleviated.

---

[1] Research Forester and Range Conservationists, respectively.

[2] Anonymous. Guidelines for fuel-breaks in southern California. U.S. Forest Serv. Pacific SW. Forest and Range Exp. Sta. Fuel-Break Rep. 9. 1963.

USE OF FUEL-BREAKS

Fuel-breaks alone are not expected to stop a hot, fast-moving fire. They are designed for offensive tactics, such as backfiring, and must be manned—usually the sooner the better. They must be further cleared to serve as control lines, but with their reduced resistance to line construction, a wide defense line can be established fairly quickly.

Fuel-breaks provide some security to the fireman. He can better estimate his safety and his opportunity for attacking successfully when he has an opened ridge or canyon bottom from which to reconnoiter and work. However, fuel-breaks, while furnishing *relatively safe* access and attack points, can lure a crew into false security. The ground cover may be flashy fuel with a rate of spread greater than that of adjacent fuels in which the fire is burning. Men should not be placed far out on a fuel-break unless larger, standard safety zones are at about quarter-mile intervals, as recommended in guidelines.

Experienced crews must quickly fire out the flashy ground fuel at the right time. Enough time is needed to plan and safely execute the firing. It is preferable not to fire when a high-intensity fire is "making a run" at the break. Wind and heat generated by a big fire close to a grass-covered break can cause many spot fires in annual grass and dry perennial grass that spread rapidly and imperil men on the line. Also, firing-out can be risky in dry grass during adverse winds because of the rapid spread of the fire and the high proportion of spots that "take". The situation may not be so critical on timbered fuel-breaks, where low-growing perennials, such as bearclover, which are not as flashy as grass, provide fuel-break ground cover.

BENEFITS OF VEGETATION ON FUEL-BREAKS

Vegetation on fuel-breaks limits their effectiveness as barriers to fire spread. Firefighters know that dry, herbaceous ground cover—specifically tall grass—is a flashy fuel which burns with much heat. However, to reduce soil erosion, such vegetation must be left on fuel-breaks or new ground cover must be established.

A dense cover of grass or forest litter is fairly stable and can be maintained free of brush quite inexpensively. However, it is first necessary to kill all brush sprouts and seedlings, preferably by chemical spraying. Killing may require 3 to 5 years, and fuel-breaks should not be started unless funds will be available to complete the job. Eventually grass or litter will usually choke out new brush seedlings and make maintenance fairly easy.

Although a grass cover may be needed on a fuel-break, all grass need not be left as hazardous dry fuel. The excess can be removed by grazing, mowing, or burning. Grass species that remain green for long periods are desirable. Techniques for management of the current vegetation growth can be developed after the heavy fuels have been modified during fuel-break construction.

A mixture of grass or litter and brush is unstable, and attempts to maintain it usually fail, or only a small acreage can be maintained because of high costs. Also, a mixture of grass or litter and low-growing brush may burn hotter than grass alone. Brush clumps, when left on fuel-breaks, may flare up from sparks and burning embers during firing operations.

Vegetation on fuel-breaks may do more than reduce erosion and stabilize ground cover. Forage grass or timber can be grown on areas formerly covered by dense brush. However, a thinned timber stand left after fuel-break construction may produce less than a natural stand, and thus add to the costs rather than benefits of fuel-break construction.

MULTIPLE-USE AND FUEL-BREAKS

Fuel-breaks must be planned and constructed as part of the total management program. Specific guidelines for fuel-break planning, engineering, and construction are usually formulated and approved by fire control specialists and timber or other resource management specialists working together under the concept of multiple-use management. The guidelines help assure that fuel-breaks are compatible with good land management. Thus, the very factors that make fuel-breaks valuable in fire control also make them valuable from a total management standpoint. Brush areas may be converted to forage grass or to timber production. Slash and other debris are cleaned off the forest floor in timber areas. Trees are thinned and pruned. The wildlife habitat is improved. Live ground cover maintained on fuel-breaks reduces erosion. The net effect of fuel modification should be higher production in both timberlands and brushlands.

CONCLUSIONS

Fuel-breaks are not cure-alls—they are prebuilt firelines that provide safer access to otherwise dangerous areas; they give the firemen a better chance of controlling fires. And, like other fire tools, they must be used for a specific purpose, in a specific place, and at a specific time.

A NEW APPROACH TO FIRELINE CONSTRUCTION[1]

R. W. JOHANSEN, *Research Forester,*
Southeastern Forest Experiment Station[1]

Backfiring from single- or multiple-plowed lines often does not control fast-spreading fires where spotting occurs. Because backfires spread slowly into the wind, they frequently do not burn out an adequate isolation strip quickly enough to stop fire spread. A new approach is needed to quickly increase the effective fireline width.

In a study in which a ground tanker with a high-output pump was used, it was shown that a chemical solution fireline can stop a head fire in the highly flammable palmetto-gallberry fuel type of southern Georgia. Fifteen percent diammonium phosphate solution was used to make chemical lines 30 feet wide and 300 feet long. A head fire was then started and allowed to run 170 feet to the treated line. Fire spread averaged 1 chain per minute. Fire did not penetrate more than 10 feet into the chemical line before the flames were extinguished, even though application rates were as low as 1 gallon per 100 square feet. The burning experiments were conducted with a Spread Index of 16-18 (High) and a Buildup Index of 30-55. Plowed lines would easily have been crossed by the spreading fire.

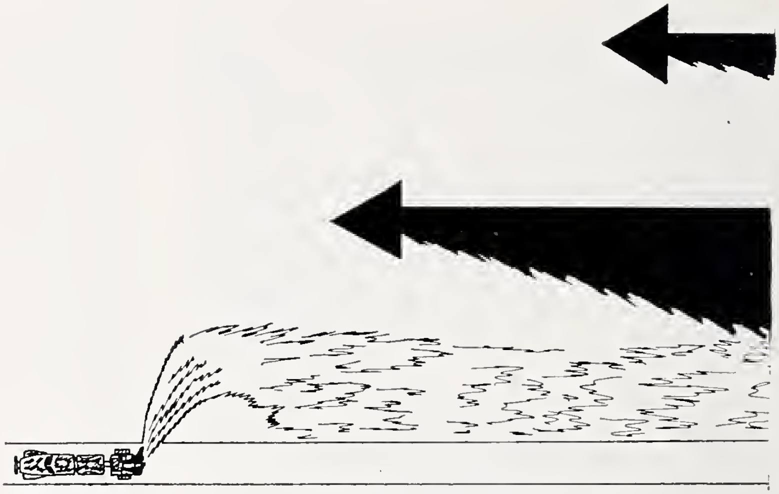


Figure 1.—Construction of a fireline with chemicals and strip head fires is shown.

This test suggested a method for the quick construction of a wide control line in front of an approaching wildfire. Instead of depending on the slow spread of a backfire to reinforce a plowed line or road, firefighters could quickly make a line by strip head firing into the prepared chemical line. Width would depend upon burning conditions. Subsequent strip head fires would quickly extend the line width to 500 feet or more if desired (fig. 1). A chemical line could also be established on the downwind side of a road; this line would be used primarily to catch spot fires. The road would serve as the fire break into which the fire would run.

The cost of diammonium phosphate would be about 2½ cents per foot of line for a 30-foot-wide line at an application rate of 1 gallon per 100 square feet. Thus, 1,000 feet of line would cost $25 and $50 for 1- and 2-gallon chemical applications.

Table 1 shows the rate at which chemical firebreaks can be completed along woods roads with mobile-pumping equipment. The rate of line construction depends on the speed of the vehicle, the pump output, and the desired application rate. For example, the table shows that a 300-gallon-per-minute pumper can supply 2 gallons of retardant per 100 square feet of land to a 30-foot-wide line while traveling at 5.7 miles per hour.

TABLE 1.—*Rate of chemical fireline construction by application rate*[1]

Rate of vehicle movement (m.p.h.)	Application	Rate
	Gal./100 sq. ft	Gal./1,000 ft. line
11.33	1	300
5.67	2	600
2.84	4	1,200
1.42	8	2,400

[1] A 300-gallon-per-minute pumper was used; the line width was 30 feet.

---

[1] The author is stationed at the Southern Forest Fire Laboratory, Macon, Ga.

Because of costs, chemicals should not be used when plowed lines and backfiring will stop fire spread. However, on high fire-danger days, when spotting may be a problem, and lines 30 feet and wider are needed quickly, the chemical lines plus variable-width strip head fires could be advantageous.

SUMMARY

Results of this study indicate that a 30-foot-wide fireline of diammonium phosphate can stop a strip head fire moving into the prepared chemical line. To provide more safety against spotting during high danger days, successive strip head fires can be used to widen the burned-out strip in the path of a wildfire.

HELICOPTERS AND FIREMEN—THE RUBY FIRE TEAM

FRED W. TYLER, *Fire Control Officer*
Saugus District, Angeles National Forest

"The helicopter will prove to be the most versatile firefighting tool ever developed." Frank C. Jefferson, Fire Chief of the Forest Service's California Region, said that about 20 years ago. . . . How true his prediction proved to be! Helicopters, when used in support of ground crews on fires, have repeatedly shown their effectiveness.

For example, helicopters and firemen united to control the potentially dangerous Ruby Fire on the Angeles National Forest. On July 23, 1965, at about 3:40 p.m., the Warm Spring lookout on the Saugus District of the Angeles National Forest detected smoke in nearby Ruby Canyon. When the initial-attack pumper unit hit the fire, it was burning on about a half acre of medium to heavy brush in the bottom of a deep canyon. The fire spotted to both sides of the canyon. The initial-attack crews, aided by air tanker support, were able to hold the fire on the south slope of the canyon. However, due to the steep slopes and dry brush, it burned over the top of the ridge on the north side of the canyon. Quick followup by hand crews and tractors held the main fire to about 500 acres.

But . . . a potentially dangerous situation had developed. As the main fire burned up the slope and approached the ridge, many firebrands carried over the fireline on the flanks and at the ridge. Many spot fires developed. However, since it was late in the day, these fires didn't flare up; they only smoldered. Crews could not have found them during the night. But many were sure to flare up the next morning when burning conditions intensified.

TEAMWORK—HELICOPTERS AND MEN

Fire control plans were needed to keep the spots from developing into a major fire in Ruby Canyon and the adjacent canyon. Three helicopters were ordered to the fire that evening; all crew and sector bosses assigned to the next day's shift were alerted to the spot fire danger. The helispot was established. Helicopter and ground crew radios were checked. Fire retardant (Gelgard) was ordered, and equipment was checked and readied for use.

By dawn of July 24th, fire crews were lined out along the fireline and the helicopters were loaded with retardant. The helicopter-firemen team was ready for action.

When it was light enough to fly safely, one helicopter flew almost constant reconnaissance. Ground crews kept alert for spot fires. At about 10 a.m. the first spot fire occurred. The reconnaissance helicopter radioed a location and condition report to the heliport and to the nearest ground crew. A helicopter dropped retardant on the fire. The retardant held the fire until the nearest crew could break through the brush and control it. This combined helicopter-ground attack continued throughout the day. Twenty-five spot fires were controlled by this team, and more than 7,000 gallons of retardant was dropped by the helicopters. It took 32 to 38 seconds, an average of 34 seconds, to fill the helicopter tank with retardant. Average flight time to the spot fires was 8 minutes. The total effort was efficient because of trained and experienced heliport crews, good air to ground communications, and the versatility of the helicopter.

SUMMARY

A team of helicopters and ground crews prevented a major fire on the Saugus District of the Angeles National Forest. The helicopters dropped retardant which kept spot fires small until ground crews could control them. The versatility of the helicopter was again proved. The helicopter can fly reconnaissance, ferry men and equipment to and from the fireline, and give ground crews the confidence they need to control the fire.

Experienced firemen believe that the combined helicopter and ground crew control of the spots prevented a major fire which could very possibly have exceeded 5,000 acres. A conservative estimate of savings in suppression costs and watershed damage is $400,000.

DEVELOPING FOAM WITH AN AERIAL TANKER

J. W. COLQUITT[1] and R. W. JOHANSEN, *Research Forester,*
Southeastern Forest Experiment Station

All forms of foam have been used to control fires. Several types of foam dispersal equipment are used with different foam systems; however, aerial tankers had not been used for dispersing foam.

After an appraisal of the different methods of producing foam—chemical, aerosal, and mechanical—the mechanical system was selected for economic reasons. A mechanical foam is generally produced by trapping air within a stabilizing liquid to form bubbles. The liquid is passed through a special nozzle, or it is introduced into a high-speed airstream such as that available in the air tanker slipstream.

OBJECTIVES

The study was initiated to establish whether air tankers could be used to dispense foams successfully. Answers to the following questions were also desired:

1. What types of foam solutions are compatable with diammonium phosphate salts?
2. What kind of volume expansion can be expected?
3. What effect do viscosity builders have on foam solutions and their foaming capabilities and stability?

PROCEDURE

Two types of foam materials were tested for air tanker use—protein-base and synthetic-base concentrates. Prior to the tests with an aerial tanker, these materials were tested in a laboratory to observe foam stability, compatibility with ammonium phosphate salts, effect of thickeners on foam formation and stability, and expansion rates.

Eight drops were made by a TBM air tanker. Except for one 400-gallon load, all solution volumes released from the aerial tanker were 200 gallons. The drop altitude was about 75 feet above the highest obstruction, unless otherwise noted.

RESULTS

Drops 1 and 2 were made with a protein-based foam concentrate in water. The first drop, a 200-gallon load, was made at 110 m.p.h. on a pulpwood-size pine stand. Complete aeration did occur, but the foam just floated into the trees with little if any force (fig. 1). The second drop, a 400-gallon load dropped at 100 feet and 140 m.p.h., was made on a flat, grassy area to assess foam expansion. The resulting pattern was 330 feet long and 220 feet wide, and the foam expansion ratio was 32:1. Foam stability was not good; the entire amount dissipated within 1 hour.

The ground pattern width resulting from a TBM retardant drop is normally 50 to 60 feet, and is not significantly affected by crosswinds of less than 10 m.p.h. However, the 220-foot width in the test resulted from an 8 m.p.h. crosswind. Therefore, the density of normal foam is low enough so that even light winds cause considerable drift.

To increase foam density, and thus overcome the drift problem, for several drops industrial gums were added to increase the viscosity of the solution. At 125 m.p.h., there was apparently not enough energy in the slipstream to aerate the solution, and no foaming occurred. At 170 m.p.h. some foam was formed, but not enough for a successful drop. The foam that did form was very stable.

The greatest foam production in the tests reported here was from a high-expansion synthetic-base concentrate in water dropped at 140 m.p.h. at 100 feet (fig. 2). Stability of this foam, however, was the

(Continued on page 11)

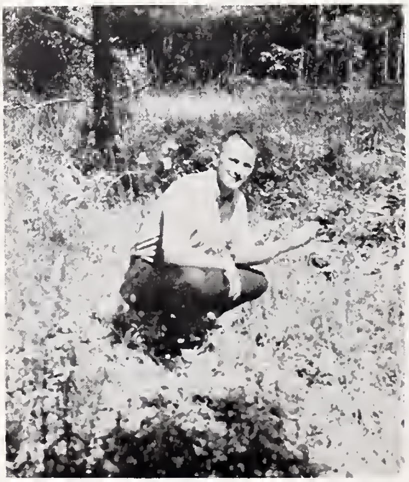


Figure 1.—Foam formed above tree crowns reached the ground mainly through canopy openings.

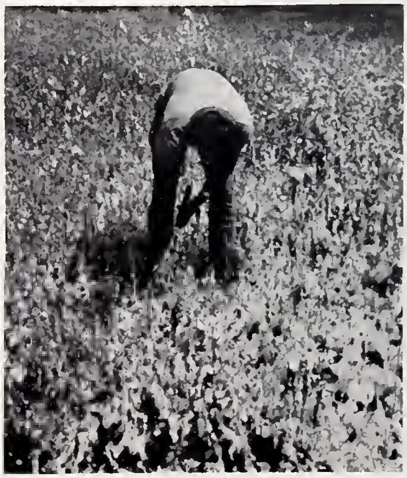


Figure 2.—A synthetic-based solution produced the most foam, but dissipation was most rapid.

---

[1] Colquitt was a Field Assistant at the Station when the work reported in this article was performed.

KEYS TO A SUCCESSFUL AIR-ATTACK PROGRAM

E. F. McNamara, *Assistant Chief, Division of Forest Protection,*
Pennsylvania Department of Forests and Waters

Pennsylvania has had a very satisfactory water-bombing program since 1960. Costs and personnel requirements are probably the two main reasons why many State forest fire control agencies hesitate to initiate a water-bombing program. Water-bombing costs must be included in the total State budget for forest fire control. To obtain maximum utilization of the few available personnel, efficient organization and operation of water-bombing programs are necessary. In order to achieve this optimum use, the Division of Protection staff has given careful attention to three critical factors: Training, preseason preparations, and operational performance.

TRAINING

Training is probably the most important of the three factors. If training is conducted properly, operational performance should be good. Our slogan has been "Every man must be trained to do as much as possible beyond his regular job." Training is conducted annually: Policies change, experienced employees require refresher courses, and there are always new employees. The training of the three men who operate our airplanes and helicopters—the pilot, air operations officer, and pump operator—is basic. In addition, the fire control organization that may work where water bombing is conducted must also be trained.

Pilot training is done in two stages, prior to and during field operations. Key points covered are:

A. Department fire control organization
B. Radio communications
C. Forest fire terminology
D. Fire behavior and fire control tactics of ground control forces.
E. Drop techniques

Pilots with water-bombing experience in Pennsylvania are used as instructors to train new men with little or no retardant-dropping experience or to train pilots whose experience has been in other States.

Air operations officers are staff foresters in the Forest District offices or qualified forest foremen working on nearby State Forest areas. These men are trained before operations, and a review and critique session is held after operations are concluded. Training includes:

A. Aircraft performance and capabilities
B. Weather and its effects on operations
C. Air-attack program policies and procedures
D. Reports and forms

Pump operators who are new employees are trained at the airbase for several days before operations begin. Experienced men usually are also given a brief refresher course just prior to the start of operations. Areas covered are:

A. Pump operation and maintenance
B. Tank capacities, control system, and retardant mixing procedures
C. Use of radio, aircraft servicing, and similar routine operational tasks.

Training for the ground fire control organization varies. The district foresters are annually briefed on old and new procedures. Circular letters are used when needed to outline new policies and policy changes. Smokechaser units (two- or three-men hotshot crews who operate from a light firetruck in areas below aircraft operations) are given 1-day training sessions on aircraft drop techniques, safety factors, and followup ground attack. The volunteer fire wardens are similarly informed at annual fire warden meetings and in periodic District newsletters.

PRESEASON PREPARATIONS

The logistics of an effective air-attack program must be decided well before operations. This is one year-round duty of the Division of Forest Protection staff, especially the air operations advisor. Some of the more important items that must be arranged, at varying intervals, before operations are listed below. Most of these are handled by the Forest District staff in whose area the airbase is located.

A. Headquarters building or van (clean, neat, and with proper heating units)
B. Telephone (connected)
C. Radio (serviced and operational)
D. Maps (up-to-date and usable)
E. Aerial photos (properly filed and available)
F. Equipment including pump, standby pump, repair parts, and tools (available and functioning)
G. Storage tanks for water and retardant (repaired, in place)
H. Water and retardant (stocked to tank capacity)
I. Telephone lists of all Department personnel and cooperating individuals, fire companies, and other agencies (up-to-date and available)
J. Forms, reports, and Instruction Manual (available)

Through great effort and use of checklists based on experience, these details and many minor ones must be checked before the arrival of the aircraft and fire weather.

OPERATIONAL PERFORMANCE

Small Airplanes

For the small airplanes (Stearmans), which have a 150-175-gallon capacity, and helicopters, the following procedures are used (fig. 1).

The aircraft are based where our studies have shown that many fires occur. They operate within a certain radius of the airbase. This radius is based on their speed and drop load.

Initial attack is the basic use for these units. Therefore, the initial fire report goes to Air Attack Headquarters, and the aircraft is dispatched immediately. To permit rapid initial attack on fires, a few false alarms can be tolerated.

If the area within the operational radius is free of fires, a plane may work on fires outside this area. Good communications permit a recall of the plane if a fire begins in the original operational area.

The small plane provides support action on fires that escape initial suppression only if it can be useful and no new fires have occurred.

In a multiple-fire situation, the air-attack officer considers the distance from the base, type of fuel, fire danger, and available manpower to determine priority of operation.

Helicopters

The procedure for use of helicopters is the same as that for small airplanes. Heliports are located on the basis of fire incidence, accessibility, and topography.

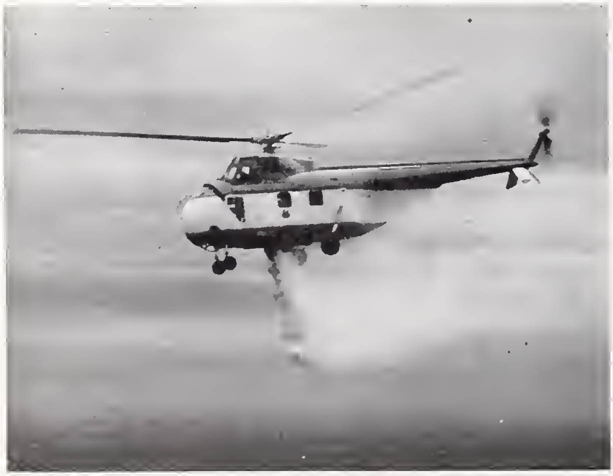


Figure 1.—This Sikorsky S-55 helicopter can carry 250 gallons of water and retardant, 125 gallons in each of two tanks. When not carrying a drop load, it can transport eight fully equipped firefighters. Its cruise speed is slightly over 100 m.p.h.

The helicopter's versatility is an important reason for its use in the air-attack program. While its use as a water bomber has priority over its other uses, helicopters have been used to transport men, equipment, and food and water to the fireline. They also permit a boss to see an entire fire.

Large Airplanes

Our experience with large air tankers has been limited to the 600-gallon TBM and the 1,600-gallon Chase (fig. 2).

Logistical problems governing the use of the TBM do not differ much from those for the Stearman. However, the operation must be from an adequately surfaced airstrip with facilities for faster loading.

The additional problems to be solved when the Chase air tanker is used are at least in proportion to the size of the Chase over the Stearman.

Only certain previously inspected airports are adequate to handle the weight of this plane when it is fully loaded. Fortunately, there are enough suitable airports in Pennsylvania to provide good statewide distribution. Two of our main operating bases, one each in the eastern and western parts of the State, handle this plane very well.

The storage facilities for this aircraft, which has a 1,600-gallon capacity, are much greater than for the 150-gallon Stearman. Also, a 50-gallon-per-minute-capacity pump is not adequate to refill the Chase. To solve many logistical problems, this aircraft carries a pump, hose, and fittings when it leaves the base to operate in another part of the State.

This large airplane is used for two types of operation. The basic guidelines for effective use of this expensive unit cover initial-attack and support action.

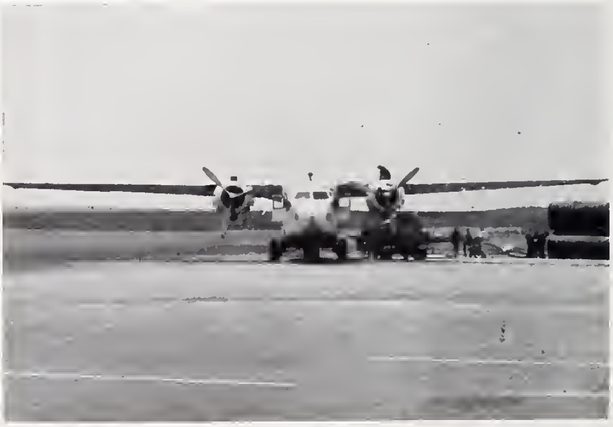


Figure 2.—The Chase, a twin-engine aircraft, can carry up to 1,600 gallons of water and retardant. It can make four drops of 400 gallons each, or two drops of 800 gallons each. Its cruising speed is 160 m.p.h.

Initial Attack

Within a 50-mile-radius attack circle of the Hazelton and Mid-state Airports, the Chase air tanker will operate on an initial-attack basis. District dispatchers needing the Chase air tanker within its initial attack circle can call the air control officer at the Air Control Center.

Within this circle, for fires reported within the operational circles of the Stearman, the latter will be dispatched on a first-call basis. However, if these aircraft are already attacking a fire, the Chase air tanker will be dispatched to new fires within the operational circles of the Stearman.

Support Action

If a large attack tanker is needed outide the 50-mile initial-attack zone, the District Office needing the aircraft must fill in a form containing basic data that will permit the Division Office to evaluate the necessity and desirability of sending the plane. These data include location and size of fire, potential area loss, and other technical data.

If the plane is not engaged in bombing operations within its basic circle and the fire potential is justifiably great, the aircraft is dipatched by the Division Office to the fire. Four auxiliary bases are cleared and processed for servicing the large bombers, and they must, after the initial drop, work from the one closest to the fire.

The tanker returns to its primary base as soon as it completes action on the fire and is released by the District, or it may be recalled by the Division Office if conditions within the primary operational circle dictate.

All the above operations are handled by the standard base crew of air operations officer, pump operator, and pilot. The Chase and one small bomber have headquarters at one base and are handled by a single crew. Two small bombers sometimes work together from a single base, and they are also handled by the standard base crew.

COST

The basic annual cost of the program, based on guarantees to contractors for the minimum operations period, is $56,000. The total cost depends on fire weather and fire frequency, particularly within the operational areas. During the severe 1963 fire year, the total cost for both water-bombing airplanes and helicopters was $71,761.19. This figure is for fire control; it did not include administrative costs for Department personnel and equipment.

CONCLUSIONS

The Division of Forest Protection believes that its air-attack program has greatly strengthened the initial attack on forest fires. More than 40 percent of all fires in the State have been suppressed when the aircraft are on contract. The cost of the program is justified because of the steady decline in average fire size. Also, by assisting small units of trained firefighters to hold fires to very small acreages, it has alleviated the problem caused by a shortage of firefighters. This acreage reduction has been achieved despite rising fire incidence and partly reflects the tremendous initial-attack capability of water-bombing aircraft.

Foam—Continued from page 8

poorest. Within 15 minutes all of the foam had disappeared. Dissipation was even quicker in diammonium phosphate salt solutions.

DISCUSSION

The rate of foam production from solutions containing liquid foam concentrates depends upon variables such as: (1) Nature of the concentrate, (2) amount of concentrate in solution, (3) solution viscosity, and (4) energy applied to the solution. The first three variables can be controlled easily, but it is difficult to regulate the energy supply in an aerial drop except within narrow ranges. The TBM tanker cannot safely carry a load at speeds under 115 m.p.h., and heavy loads should not be released at speeds exceeding 160 m.p.h. due to extreme negative G-force stresses that develop on the wings.

Water solutions of some foam concentrates tested did foam readily when released from the air tanker at normal drop speeds. However, the foams produced were light and very susceptible to drift, and were not very stable. The water quickly flowed down the film surfaces to the ground, leaving a "dry" foam residue.

In the laboratory foam stability and density are both improved by the addition of industrial gum thickeners, but more energy is required to make foam from thickened solutions. Enough energy to adequately aerate such a solution is not available in the airstream of a tanker travelling at 150 m.p.h. However, tankers capable of dropping at higher speeds may be able to lay a stable foam line.

The use of foaming agents in firefighting chemicals dropped from aerial tankers does not seem promising. But foaming can occur in a free-falling liquid drop from a tanker, and when further improvements in foam concentrates are made, new evaluations may be useful.

FIGHTING FIRE WITH HIGH-PRESSURE AIR JETS . . . SOME PRELIMINARY RESULTS

DEAN L. DIBBLE[1] and JAMES B. DAVIS, *Research Forester,*
Pacific Southwest Forest and Range Experiment Station

Water is the traditional medium for fighting fire. But in some areas, water may be scarce, hard to obtain, or costly. The possibility of using a substitute for water, such as air, has interested many foresters. The idea is not new. Nearly 30 years ago, Lorenzen[2] reported on the use of compressed air in fire suppression. Other articles have since appeared. Also, another medium, high-expansion foam—produced by flowing air through a detergent system—has been tried.

Most investigators have considered air as a propulsion force for water, for blasting litter from the fireline, or for modifying wind patterns. However, the direction of an airblast at the fire has been tried only a few times, and most of these attempts have involved a large-volume, low-pressure airstream generated from some distance.[3] What would happen if a high-pressure jetstream was applied directly to the base of the flames?

LABORATORY STUDY

To determine the feasibility of this technique of fire suppression, a small-scale laboratory study was conducted at the University of California's Richmond field station in the spring of 1965. An attempt was made to extinguish fires burning in 7- by 12- by 36-inch chicken wire cages filled with excelsior in amounts equivalent to dry grass weighing 800 to 16,000 lbs./a. Similar tests were made with assemblies of 1/2-inch-diameter pine dowels. The fuel loading of these dowel assemblies was equivalent to 320,000 lbs/a. One end of the fuel was ignited, and after the fire became established, an attempt was made to put it out with a compressed airblast. Various airflow rates, pressures, and techniques were tried.

Success depended almost entirely on a combination of fuel arrangement and air pressure that permitted the airblast to penetrate through the unburned fuel to the base of the fire. If the air could penetrate, the extinguishment was quick—probably quicker than could have been accomplished with water. But if the fuel arrangement prevented penetration, the airblast formed eddies that actually spread the fire. Fires could be blown out consistently with air at 100 p.s.i. when fuel loading did not exceed the equivalent of 8,000 lbs./a.

PRELIMINARY FIELD TESTS

Next, preliminary field trials were conducted early in the summer of 1965. A trailer-mounted compressor was used as our "fire engine". This piston-type compressor had a capacity of 131 c.f.m., 100 p.s.i. It was equipped with 100 feet of standard airhose and a "forester"-type nozzle. Grass volume at the test site was relatively high (6,000 lbs./a.) (fig. 1). Burning conditions were moderate.

After blowing out eight fires, we concluded that the air-pressure technique was slower than water. Also, this technique was not always dependable. As in the laboratory, difficulty was experienced where the fuel was matted and air could not penetrate to the base of the fire. However, the technique did offer some promise; we never ran out of air or had to go for a new load. Consequently, we decided to combine techniques.

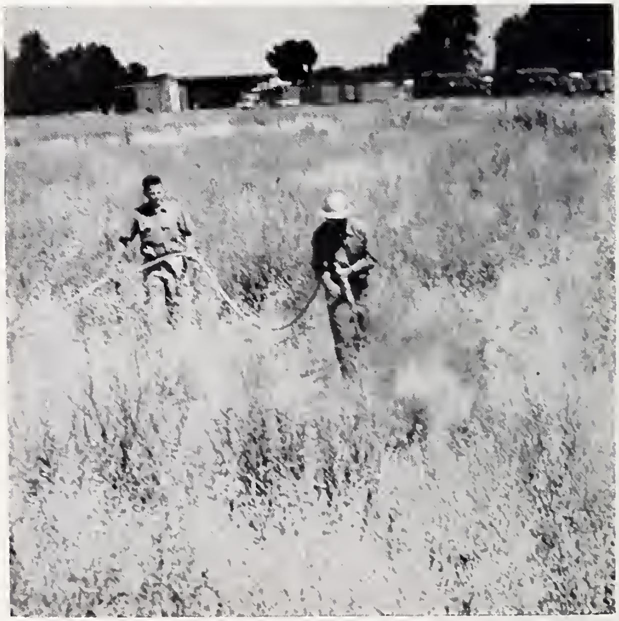


Figure 1.—This crew is fighting a grass fire with air from a trailer-mounted compressor.

---

[1] Dibble was a Meteorology Technician at the Station when the work reported in this article was performed.

[2] Lorenzen, C. Tests on the use of compressed air in fire suppression. U.S. Forest Serv. Fire Control Notes, 22 pp., illus. 1939.

[3] Forest Service, USDA. A wind machine and fire control. U.S. Forest Serv. Firestop Progr. Rep. 8, 8 pp., illus. 1955.

We retained the airblast equipment and designed and built a small tank truck consisting of a pressurized 125-gallon water tank and 25-gallon tank for powdered fire retardant (flow-conditioned diammonium phosphate). The system was piped so that the crew could use either air, water, or retardant powder. The same hose and nozzle system was used for all three media. (fig. 2).

Since tanks pressurized with compressed air are potentially dangerous, they were designed with required safety tolerances and equipped with gages, regulators, and safety valves. Both the air and water systems worked very well. The unit could handle an airflow of 131 c.f.m., with a nozzle pressure of 90 p.s.i. The water system delivered about 20 g.p.m., with a nozzle pressure of about 80 p.s.i. The compressor did not have to be operated continuously when water alone was used. Once the tank was pressurized it could expel itself just like a rural-type pressure system. However, the powder system developed difficulties—the powder often became wet or caked.

FIELD TRIAL

The tank truck unit was used in 14 test fires in 1965. Each test plot was 100 feet square. Fuel was annual dry grasses that averaged about 3,000 lbs./a. The fire danger rating was usually "high". Other pertinent data were as follows:

Temperature	89-96° F.
Relative humidity	15-22 percent
Fuel moisture stick	2.2 percent
Wind velocity	3-8 m.p.h.
Burning index (grass)[1]	16-20

[1] California Fire Danger Rating System.

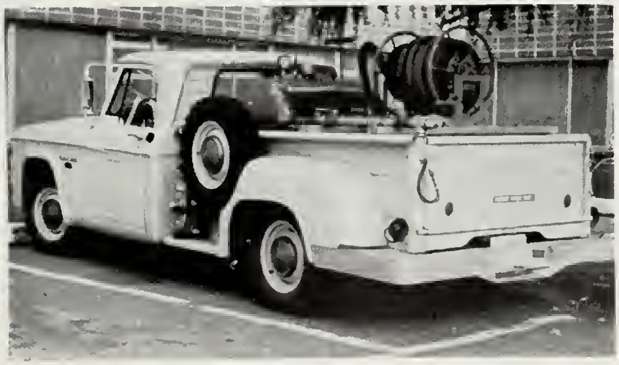


Figure 2.—This test truck is equipped with airblast, water, and retardant powder systems.

We started the fires at the upwind edge of the plots and began putting them out as soon as they had reached a uniform front. Although compressed air alone put the fires out in 10 of 12 trials, it took four times longer than water (table 1). In two trials the fire became so intense that it was necessary to rapidly switch to water to protect the nozzleman.

We also had 10 times more rekindles when the airblast was used. This number probably occurred because the nozzleman was too busy trying to stop the fire to be careful.

TABLE 1.—*Comparative fire suppression time using water and air*[1]

Fire number	Extinguisher	Time required for extinguishment	Rekindles
No.		*Seconds*[2]	*No.*
1	Air	68	4
2	....do....	69	4
3	....do....	64	3
4	....do....	77	8
5	....do....	65	5
6	....do....	68	4
7	....do....	64	3
8	Water	14	1
9	....do....	16	0
10	Air	[3] 60	----
11	....do....	67	2
12	....do....	68	5
13	....do....	[3] 58	----
14	....do....	66	2

[1] Wind—NW, at 3 to 8 m.p.h. with gusts of 12 m.p.h.

[2] Time needed to put out a line of fire 100 feet long.

[3] Water needed for final control for protection of equipment.

The most effective firefighting technique with the airblast was to start from an anchor point and progress along the fire edge, blowing the fire back into the burn. Much eddying and erratic fire spread resulted when the nozzleman started in the middle of a burning line. Airblasting is a special safety problem. Because air does not have a trajectory and will not carry like water, the nozzleman had to work closely ahead of the fire in the unburned fuel.

Two trials were conducted using air in an indirect attack; the results were disappointing. Al-

(Continued on page 15)

FIRE WEATHER TELEMETRY

Frank E. Lewis, *Forester,*
Forest Service Electronics Center, Beltsville, Md.

Telemetering is a system employing electronic instruments to measure quantities, transmitting the result to a distant station, and there indicating or recording the quantities measured. It sounds simple all right! Is it applicable to protection of forest and range lands from wildfire?

Fire control managers have long noted the lack of information on weather conditions in remote areas and on many midslope locations.[1] [2] In mountainous country, manned stations are few and are usually in the valleys or on ridgetops. Also, with the increasing use of aerial detection, in many areas lookouts are no longer available to make weather observations. Samples have been inadequate and dependable data has been expensive to obtain.

Telemetering weather conditions has been perfected using several systems. Various degrees of success have been obtained for many years, both by the military and others. Several systems are commercially available. However, generally the systems are too expensive or/and require too much attention by technicians for widespread use in fire protection.

Since the late 1950's, considerable work in developing a dependable, economical fire weather telemetering system specifically for fire danger data has been done at the Forest Service Electronics Center, Beltsville, Md. Extensive field tests continue, but contract costs, exclusive of weather sensors and communications equipment, remain high. Two operational systems based upon earlier basic designs were delivered to the Forest Service during 1966. They have been installed on National Forests in Montana and Wyoming and by the Bureau of Land Management in Nevada. These systems and their functions are described as follows:

The control station (fig. 1) consists of a control console with a modified electric typewriter and radio equipment. Data is transmitted by the various observation stations upon radio command and is automatically recorded on the typewriter. The central station can be programed to operate unattended and obtain reports at preset observation times.

The console is 20 by 18½ inches and weighs 80 lbs. It operates from a 60-cycle, 105-125-volt power source and draws 20 watts. The unit, exclusive of radio equipment, costs about $3,200.

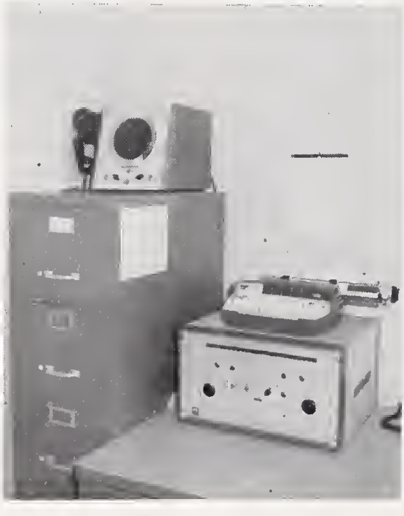


Figure 1.—Control station console and radio equipment.

A set of weather sensors is used to measure weather conditions at the observation station (fig. 2). The sensors convert the data into electrical quantities. The set costs approximately $700.

The circuit components and relays which process the information for radio transmission are mounted on panels in a standard 40- by 19-inch relay rack.

The total weight is 85 lbs. The equipment operates from a 24-volt battery pack composed of 16 No. 6 industrial dry cells. One pack will operate the unit for a full fire season. The cost of this equipment is approximately $4,000. This does not include radio equipment, which is housed in a separate enclosure.

The station monitors the following five parameters of weather over the indicated ranges:

1. Wind direction, 8 cardinal points of the compass
2. Wind velocity, 2 to 60 miles per hour

(Continued on page 16)

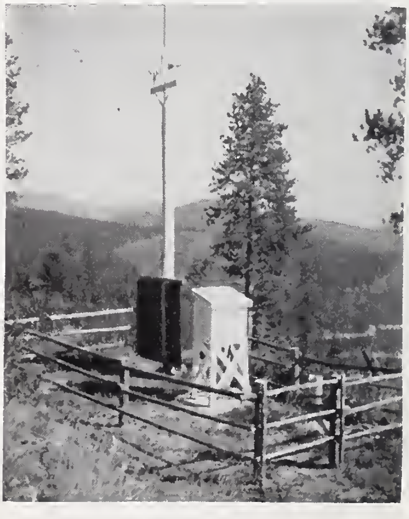


Figure 2.—Telemetry station No. 4 on Point Six near Missoula, Mont.

---

[1] Tucker, James B. Planning the locations of fire danger stations. Fire Control Notes 21 (2): 46–47. 1960.

[2] Keetch, John J. Developing a network of fire danger stations. Fire Control Notes 25 (4): 3, 4, 6. 1964.

Air Jets—Continued from page 13

though the technique has been successful elsewhere in leaf litter fires[4,5], enough dry grass could not be removed to stop the fire.

CONCLUSIONS

The airblast method alone is not as effective as water for controlling a running fire in medium to heavy grass. Furthermore, it is more hazardous to men and equipment. An adequate compressor is expensive and heavy. A compressed air system without proper engineering and required safety features can be dangerous.

However, if fuel is light, water scarce, and the compressor can be used on other jobs, airblasting may be practical—particularly if it can be combined with a water system. The airblast looks promising for mopup in light fuels. Large compressors used for construction of forest roads could be sent to the fire for this purpose.

An airstream to propel water and fire retardant liquids and powders also has promise. Our water system worked well, and we expect our powder system to do a good job when it is reengineered. Related studies, here and elsewhere, have shown the effectiveness of portable backpack-type mistblowers for delivering both liquids and powders. The study of firefighting with air jets will be continued.

---

[4] Nicloles, J. Mand, and Paulsell, L. K. A new idea in firefighting: Airblast line building. Univ. Md. Agr. Exp. Sta. Bull. 725, 7 pp. illus. 1959.

[5] Welsh, J. L. Backpack mistblower as a fireline builder. U.S. Forest Serv. Fire Control Notes 26(7): 2 pp., illus. 1964.

Carolina Blowup—Continued from page 3

reported across from Melvin's store." "Fire has jumped the South River into Sampson County." "Fire burning two homes and a half-dozen farm buildings on Beaver Dam Church Road." Fire was everywhere!

By 3 p.m. the Ammon fire had jumped Cedar Creek Road and was headed toward the settlements. The district dispatcher reluctantly pulled a unit off the Black Lake fire, now only 10 miles away, and committed his last reserve tractor plow.

Still the flames continued their advance. Air tankers of the North Carolina Forest Service cooled hot spots and were credited with helping volunteer fire companies save several homes and outbuildings.

Evening came with a smoky orange light. Down in the swamp the fire rumbled. The cane went up with a crackle that sounded like a rifle platoon in action.

The cold front hit the Ammon fire at 7 p.m. As expected, the flames changed direction. Already the Whiteville District Forester was headed toward N.C. Highway 242 which now lay in front of the fire. Control was impossible now, but he wanted to be sure everyone was out of the way.

FLAME—150 FEET HIGH

Smoke was intense. The fire could be heard in the distance, and the glow of the flames appeared through the forest. Then the pines across the highway exploded into what he described as a sheet of flame 150 feet high.

Simultaneously, three lightning bolts from the thunderheads overhead accompanying the cold front struck the main fire. As rapidly as it came, the fire moved on, throwing burning limbs and brands 1,000 feet ahead of it. Finally, the skies opened up with a brief downpour that knocked the flames out of the trees until there was nothing but flickering snags in the night.

Tractor units spent the night plowing lines, but without the flames to guide them it was hard to locate the leading edge in the dark. The situation was made more difficult by the many small spot fires that were scattered out ahead as far as a quarter of a mile.

The thundershower was only temporary relief. Severe burning conditions were forecast for the next day. Again and again crews sought to strengthen their plowlines, but the backfires would not burn. Without fire, they were unable to construct a fire-break wide enough to hold a new onslaught.

As expected, a drying wind came up with the sun on April 2. By mid-morning the scattered embers were fanned to life. Crews worked in vain. Flames were rolling again and took little notice of the lines that had been plowed across their path. The Ammon fire had places to go and another 10,000 acres to burn before a general rain and a massive control effort would contain it 2 days later.

Yes, April 1, 1966, will be long remembered in the Carolina pinelands. But the severe test was well met by courageous firecrews and modern equipment.

U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON. D. C. 20250

OFFICIAL BUSINESS

U. S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

MARKING FIRE HANDTOOL HANDLES[1]

REGION 10, *U.S. Forest Service,*
Juneau, Alaska

A quick, efficient method of painting fire handtool handles for identification is described.

1. Select a piece of cloth 6 to 8 inches wide and 20 to 30 inches long.
2. Fold the cloth to the desired width of the identification band to be painted.
3. Fasten each end of the cloth to a solid, secure item. The ends should be approximately 25 inches apart (fig. 1).
4. Apply a coat of paint to the upper surface of the cloth. By folding the cloth several times, it will be able to hold plenty of paint.
5. Place one hand above the section to be painted and the other hand below the section. Thus, the handle will be at a 90° angle to the cloth.
6. Lower the handle to the cloth.

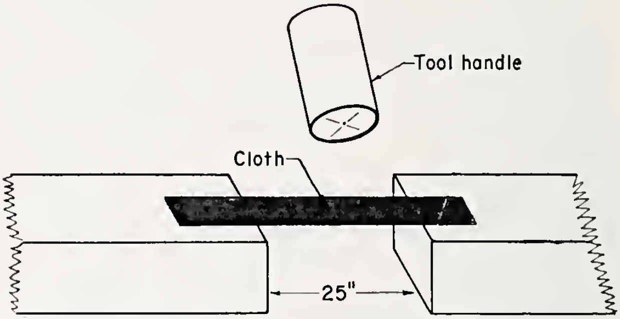


Figure 1.—Diagram of components used in painting fire handtool handles.

7. Rotate or roll the handle 360° to provide a smooth, even, continuous band of paint.

Approximately 10 handles can be painted before more paint must be added to the cloth.

---

[1] Adopted from R-10 Forest Service Handbook, FSH 5125.3, Fireman's Guide.

Telemetry—

Continued from page 14

3. Humidity, 0 to 99 percent relative humidity
4. Temperature, 0° to 129° F.
5. Precipitation, 0 to 99.99 inches

Equipment used for radio communication between a central station and its satellites are a standard VHF transmitter and receiver units. Central station equipment is typically a 25-watt tabletop console. Observation stations generally use an FM 3-watt battery-powered portable packset. Surplus older radios can often be used to perform the required function, thus saving an investment in equipment exclusively for telemetering.

Central stations, of course, must be at some suitable headquarters. Observation stations for a system should normally be at sites 2 to 25 miles from the central station, depending upon the needs of the rating area. Some of the more remote installations might require intervening repeater stations for reliable system performance. Up to 10 observation stations can be tied into one central station.

The fire weather telemetry system described above was designed to be compatible with the needs of the National Fire Danger Rating System. The equipment is capable of accommodating inputs from additional sensing equipment should it later prove necessary, but efforts are now directed mainly toward simplifying the system to reduce initial investment costs. Once reasonably dependable and economical equipment is available, use of telemetry to provide coverage for protection areas as large as an entire National Forest would be feasible. The data gathered by telemetry could be integrated with that gathered and transmitted by ordinary methods already in use.

Ultimately, improved sampling techniques and better knowledge of fire weather and fire behavior may permit use of totally automatic systems, tied into fire danger computers located at central points.

serve
766Fi

FIRE CONTROL NOTES

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
MAY 31 1967
CURRENT SERIAL RECORDS

U.S. DEPARTMENT OF AGRICULTURE / FOREST SERVICE / APRIL 1967 / VOL. 28, NO. 2

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Page

3 Development of Slip-on Forest Fire Tankers
Carl E. Burgtorf

5 Loma Rica Air-Attack Base
Ed Corpe

6 Importance of Coordinated Air-Ground Attacks: A Comparison of Two Fires
Paul G. Snowcroft, James L. Murphy, and Lynn R. Biddison

8 Railroad Fires in Oregon
James B. Corlett

Page

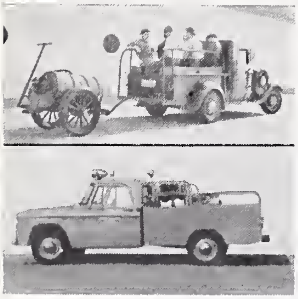
9 A Weather Briefing Board for Fire Control
D. John Coparanis

11 A Modern District Warehouse
Donald H. Marriott

12 Marking Permanent Helispots With Fiberglas Panels
P. A. Theisen

13 The Relation of Spread Index to Fire Business in Connecticut
John J. Keetch

15 Children With Matches
National Wildlife Federation Conservation News



COVER—Small forest fire fighting tankers—early 1930's and 1967. See related article on page 3.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

DEVELOPMENT OF SLIP-ON FOREST FIRE TANKERS

Carl E. Burgtorf[1]

Firemen have been working for more than 25 years to increase the versatility of tanker trucks for forest fire suppression. Development of these units in the 1930's was restricted because few types of pumps and vehicles were available. Many early tankers were single-purpose units permanently installed on 1½- or 2-ton trucks; they held 250 or more gallons of water. Pumps were usually power takeoff models driven by the truck's engine.

Because of their expense, these single-purpose vehicles could not be provided in sufficient numbers to meet all the needs for tankers during emergencies. This fact, and the availability of improved equipment, soon prompted the development of the inexpensive slip-on unit—a tank, pump, and related accessories—which could rapidly be mounted on any stake bed or pickup truck.

As the effectiveness of smaller tankers, with their better mobility, was recognized, the larger tank trucks were more and more supplemented by small slip-on patrol tankers. The availability of the military four-wheel-drive jeep resulted in more use of the slip-on tankers. In many areas water could be delivered closer to the fireline.

The small slip-on-tanker became an efficient forest fire fighting tool as emphasis was switched from attempting to provide large quantities of water at the fireline to skill in applying small amounts effectively. Firemen were trained to use water from these small tankers to knock down the flames and cool the line to allow handcrews and line-building equipment to work more efficiently and safely. As the use of slip-on units grew, they were constructed in greatly differing designs and sizes for a variety of applications. This led to Service-wide surveys to provide direction in further development of slip-on equipment.

In October 1946, a list of all types of fire equipment in use included two styles of gear pumps and one centrifugal pump. Tanker types, by rated vehicle capacity, included an R-7 ½-ton, R-6 ¾-ton, R-9 ¾-ton, R-5 1½-ton, R-6 1½-ton, and an R-5 and a State of Michigan slip-on unit.

A second survey was conducted in 1955. The list of tankers in use showed the increasing popularity of smaller units, for it included the 50-gallon slip-on patrol tanker, 70 of which had been purchased in the 1950-54 period. In the 60- to 200-gallon sizes, 200 slip-on and fixed-mount tankers had been purchased during this same period. There were 153 larger (250- to 360-gallon) tankers purchased.

To provide uniformity in design, a Service-wide specification was issued in August 1955 for the 50-gallon patrol slip-on unit. In 1965, the specification was revised to incorporate improvements, but the unit is still a small patrol tanker (fig. 1).

In 1964, a Service-wide project for slip-on tanker updating and standardization was assigned to the San Dimas Equipment Development Center. All regions were canvassed to determine what types of equipment were in use and to obtain suggestions for improvements. Nearly 1,500 slip-on tankers were inventoried (table 1).

Table 1.—*Slip-on Tankers by Regions and Tank Sizes*

Gallons	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	Total
50	10	57	58	10	111	103	7	29	51	....	436
60-80	4	15	0	4	155	34	4	5	7	0	228
100-125	18	42	0	8	34	43	8	6	8	0	167
140	18	9	0	14	0	0	0	40	7	0	88
160-175	22	7	0	16	9	85	8	0	28	0	175
200	36	8	40	33	4	45	2	5	10	0	183
250	0	3	0	18	21	0	1	5	2	1	51
300	6	3	0	2	61	14	0	1	3	0	90
400-1,400	7	7	0	9	0	14	0	0	0	0	37
Totals..........	121	151	98	114	395	338	30	91	116	1	1,455

---

[1] Former Forester, Division of Fire Control, Washington, D.C. (retired).

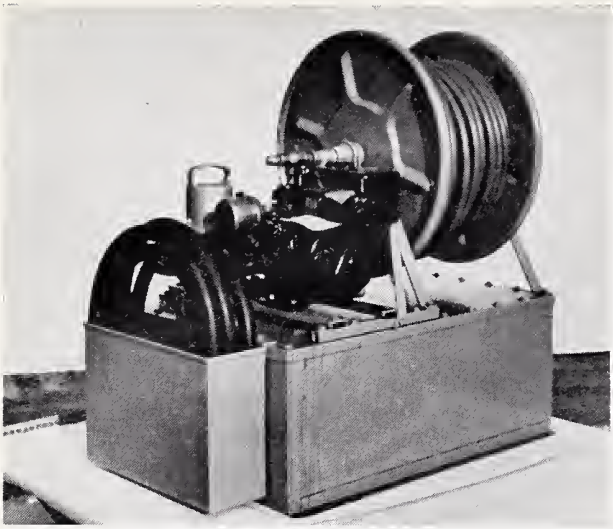


Figure 1.—The compact 50-gallon slip-on unit requires little space and is simple to operate.

The trend within Regions has been toward standardization of sizes, types of pumpers, and plumbing used on the forests. This trend has been adversely affected by the diversity of commercial pumping equipment and by various adaptations of this equipment in the field. In 1964, more than 12 tank sizes (40-200 gallon units) were reported. The greatest deviations in ground tanker usage were in nomenclature and in plumbing styles. The latter varied by forests, and some installations were haphazardly reducing the efficiency of the pumping unit.

The status of the Service-wide Slip-On Tanker Updating and Standardization Project represents a consolidation of many good tanker design features in use or commercially available. Several manufacturers have produced pumping equipment for more than 30 years. They have made many improvements in design. Most of their products have been developed in close coordination with experienced firefighters. For example, it has been decided to end mount the pump and motor at a level with the tank base on some tankers developed at the Center (fig. 2). Such mounting improves the driver's rear vision, lowers the center of gravity of the unit, and with centrifugal pumps, prevents draft problems. This mounting will be new to some areas. But a Mississippi pump company has manufactured end-mounted pumps for many years for use in Eastern States.

(Continued on page 16)

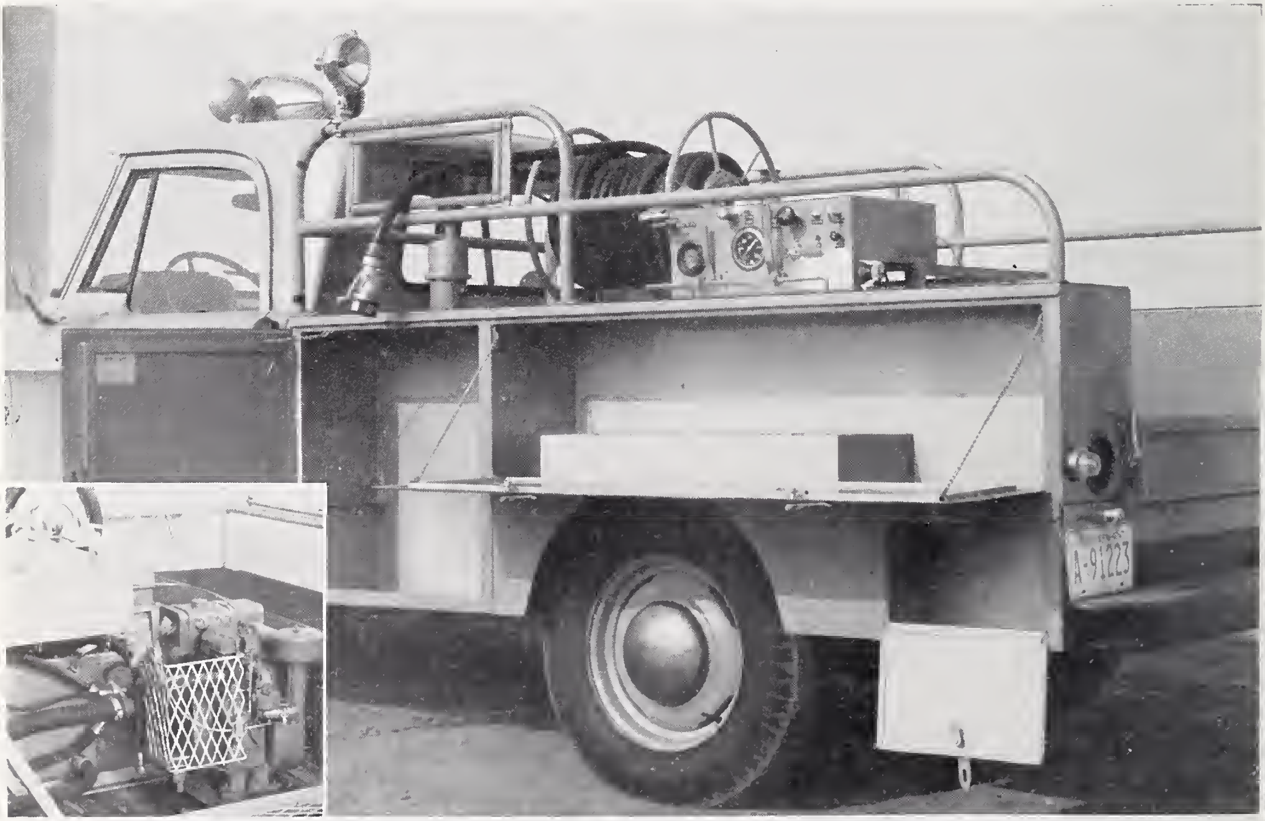


Figure 2.—This 75-gallon metal tank slip-on unit is mounted on a pickup with Low Silhouette body equipped with guardrails and hose reel guide. The inset shows end mounting of the pump. This series is also available in 125- and 200-gallon tank sizes.

LOMA RICA AIR-ATTACK BASE

Ed Corpe, *Deputy Forest Supervisor*
Lolo National Forest[1]

The Loma Rica Airport, adjacent to the Tahoe National Forest in Nevada County, Calif., was first used for airtanker operations in 1957. However, due to its short runway, it was suitable only for single-engine aircraft such as the TBM.

A decision in 1964 by the Federal Aviation Agency and Nevada County to extend the runway to nearly 1 mile, permitting multiengine airtanker operations, and to construct taxiways, which would have crowded existing airtanker facilities, provided an opportunity for planning a new and expanded airtanker base.

FEDERAL-STATE COOPERATION

Both the Forest Service and the California Division of Forestry recognized the need for improved air-attack facilities in the area, and the planning and construction of the new base was a joint effort. The key factor in the final successful development of this modern installation was the full cooperation between the two agencies. The Forest Service purchased the site, provided limited financing, furnished the engineering design, and gave high priority to the acquisition of surplus equipment and material. Heavy equipment and conservation camp crew labor were furnished by the California Division of Forestry.

Improvements include three concrete slab fillports spaced for simultaneous loading of three B-17 airtankers; increased retardant mixing and storage capabilities, including electric pumps and a retardant recovery system; better facilities for the office, pilot's readyroom, shop, and warehouse (all in one building); and an improved taxi-traffic pattern (fig. 1).

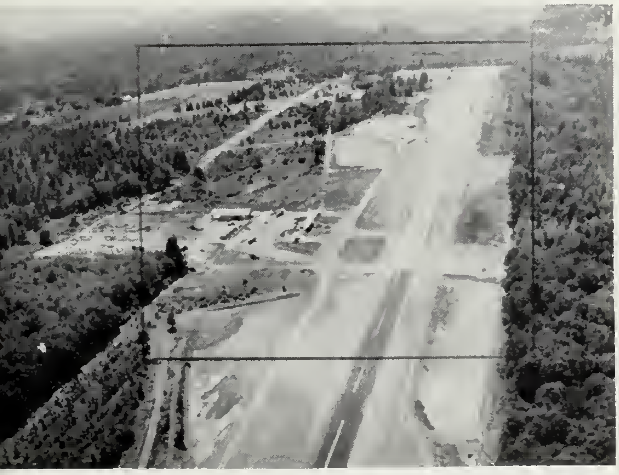


Figure 1.—Aerial view of Loma Rica air-attack base is shown.

CONSTRUCTION

Construction was carried out in two stages to permit the existing facilities to remain operational during the 1965 fire season. In the early spring of 1965, work started on the first phase. More than 14,000 yards of fill was placed and compacted on the sites for the aircraft area; the retardant mixing and storage delivery lines, water lines, communications lines, and electrical conduits were placed in the same ditch.

At the end of the fire season, the second stage of construction began. After final filling and grading, base rock was spread on the site, and mixers, tanks, and pumps were moved in from the old base. Pierced steelplate was installed as temporary paving until an asphaltic concrete mat could be laid.

THE NEW BASE

The base, which was operational during the 1966 season, has double batch mixers for use with a long-term retardant such as Firetrol; they have a capacity of 12,000 gallons per hour. A 200-gallon-per-minute gravity-feed mixer is used for a short-term retardant (such as Gelgard). Four storage tanks hold 62,000 gallons of slurry. The retardant is delivered to the fillports by three electric pumps (with 500-, 600-, and 800-gallon-per-minute capacities. (fig. 2) When the largest pump is used, an F7F airtanker can be loaded in less than 90 seconds. A

(Continued on page 15)

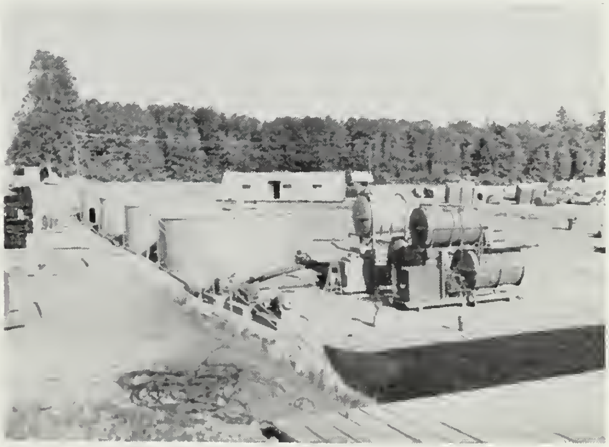


Figure 2.—View of batch mixers, storage tanks, and loading pumps during installation.

---

[1] Former Fire Control Officer, Tahoe National Forest.

IMPORTANCE OF COORDINATED AIR-GROUND ATTACKS: A COMPARISON OF TWO FIRES

Paul G. Scowcroft, James L. Murphy, and Lynn R. Biddison [1, 2]

"Send in air tankers!" In recent years this order has become increasingly familiar when a forest fire started. But experienced firefighters know that the use of air tankers is expensive and that other fire control methods may cost less. Therefore, "Don't send in air tankers" has become an equally familiar order. When air tankers are sent, the most effective fire control action is a well-coordinated air-ground attack.

There are only a few well-documented cases of significant air-ground attacks. This article describes two fires that started 7 years apart on nearly the same location on the San Bernardino National Forest in southern California. The Monkey Fire of 1965 was potentially more dangerous than the Monkey Face Fire of 1958. But the 1965 fire was controlled at 35 acres in 3 hours, and the 1958 fire was controlled at 600 acres in 53½ hours.

This difference was due to several factors; these included greater use of air tankers, improved fire retardants and mixing-loading techniques, and better management of men and machines—especially in coordinating the air-ground attack. All other factors were important only because of this last factor. A study of the two fires suggests that a coordinated air-ground attack supported by properly trained hot shot crews can reduce the cost of putting out a forest fire.

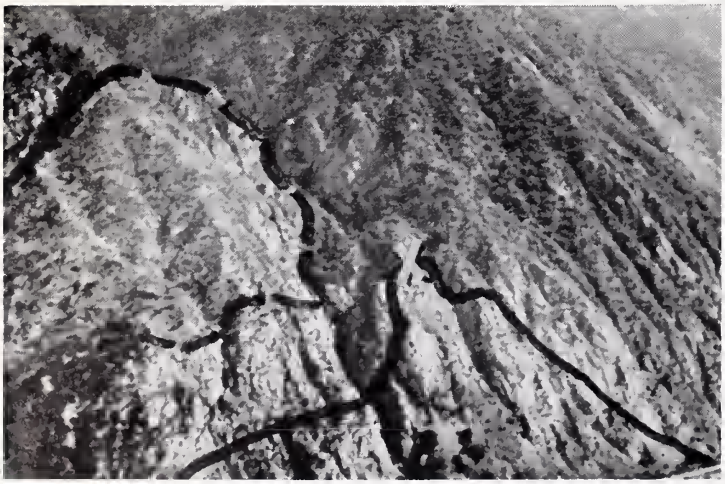


Figure 1.—Head of the fire in 1965 was stopped by air attack at point X. Slopes were steep and heavy cover was ahead of the fire. Broken line indicates area of 1958 Monkey Face Fire; continuous line indicates area of 1965 Monkey Fire.

THE TWO FIRES

The Monkey Face Fire began at 12:30 p.m. on July 8, 1958, and the Monkey Fire started at 2:05 p.m. on August 6, 1965. The two fires started one-half mile apart on the same steep mountain slopes dominated by heavy chamise and chaparral (fig. 1). They occurred at about the same elevation, and the average slope of the fire areas was about the same.

A comparison of the two fires shows their similarity:

Item	Monkey Face Fire, 1958	Monkey Fire, 1965
Location	T. 1 S., R. 1 W., sec. 11	T. 1 S., R. 1 W., sec. 11
Elevation	4,600 feet	4,415 feet
Slope at origin	+45 percent	+4 percent
Average slope	+130 percent	+140 percent
Fuel type	Heavy chamise and chaparral.	Heavy chamise and chaparral.
Date and time of origin.	July 8, 1958 (12:30 p.m.)	Aug. 6, 1965 (2:05 p.m.)
Date and time of attack.	July 8, 1958 (12:43 p.m.)	Aug. 6, 1965 (2:17 p.m.)
Control time	53 hours, 31 minutes	2 hours, 55 minutes
Area at discovery	<1 acre	<1 acre
Fire load index	13 (high)	53 (extreme)
Rate of spread at discovery.	100 chains per hour	60 chains per hour
Character of fire	Spotting	Spotting

The 1965 Monkey Fire had at least four times the damage potential as the 1958 fire; this fact was indicated by the large difference in the fire load index.[3] One item—rate of fire spread at discovery

---

[1] Snowcroft and Murphy are Research Foresters, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif. Biddison, formerly a Research Forester at the Station, is a Fire Staff Officer, San Bernardino National Forest.

[2] The assistance of Everett Waterbury, Air Attack Specialist, San Bernardino National Forest, in gathering and preparing certain data and information for this article is gratefully acknowledged.

[3] A combination of the ignition and burning indexes in the California Wildland Fire Danger Rating System. The adjective rating for a fire load index of 53 is "extreme."

—seemed to contradict the existence of greater damage potential in 1965. The difference in rates was attributed to the slopes on which the fires were burning when discovered. As the 1965 fire approached the canyon walls, the slope more nearly equaled that encountered in 1958; thus, the difference due to effect of slope was diminished. Once the Monkey Fire reached the steep slopes, under the extreme burning conditions, the rate of fire spread probably exceeded that of the 1958 fire.

AIR ATTACK AND HOT-SHOT CREWS—THE ONE-TWO PUNCH

During both fires the ground crews had to scale steep (135 percent) slopes, and the fire head easily moved faster than the crews. Air tankers operated from Ryan Field, 26½ air miles away, were dispatched to both fires.

In 1958, air tankers dropped 5,000 gallons of borate on the fireline. Helicopters were not used to deliver retardant.

In 1965, air tankers made 16 runs, dropping more than 10,500 gallons of Firetrol and Phos-chek[4] on the flanks and head of the fire. Fire spread slowed or stopped on about 55 chains of the fire's perimeter. Two helicopters also made small drops on hotspots. The checkline held for 2 hours, allowing the hot-shot crews to construct a final fireline around the fire's head. If the fire had not been checked, it probably would have moved into the San Gorgonio Wilderness area and burned about 1,500 acres of heavy fuels on steep terrain where there are no roads and few trails.

A comparison of the suppression forces used on the two fires follows:

Item	Monkey Face Fire, 1958	Monkey Fire, 1965
Initial-attack forces.	One man with handtools.	One man with handtools.
Followup forces	Hand crews, ground and air tankers.	Hand crews, ground and air tankers, and ground machines.
Maximum number of line workers.	516	215
Ground tanker line.	11 chains	105 chains[1]
Air tanker line	0 chains	55 chains
Ground machine line.	0 chains	5 chains

[1] The tanker line was increased almost tenfold in 1965 because the fire originated on the valley floor and more perimeter could easily be reached by hoselays. The 1958 fire began on the slopes of the mountain.

COSTS AND DAMAGES

Costs and damages were higher in 1958 than in 1965. Suppression costs were $160,000 in 1958 but only $19,160 in 1965. Estimated damages to resources amounted to $33,210 in 1958 and $300 in 1965. In addition, an indirect cost was incurred in 1958 when rain from a thunderstorm swept more than 40,000 cubic yards of debris from the burned area (fig. 2). About $100,000 was spent to remove the debris and clean up the area.

The erosion potential was far greater in 1965 because in November and December of that year, southern California had the heaviest rains of the past 25 years. Yet, no measurable erosion or production of debris resulted. And there was no damage which would have required expenditures for repair.

The savings in suppression costs and damages as a result of effective combined air-ground attack on the 1965 Monkey Fire totaled $274,520—even after adjustment for the declining value of the dollar.

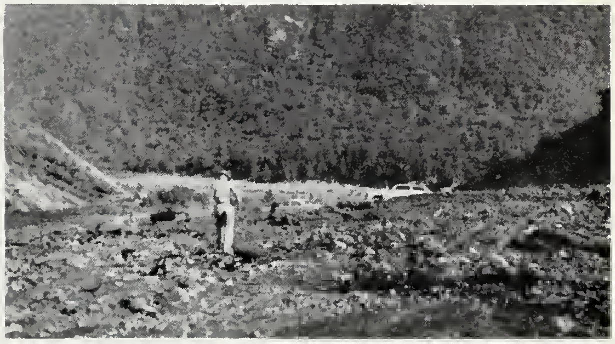
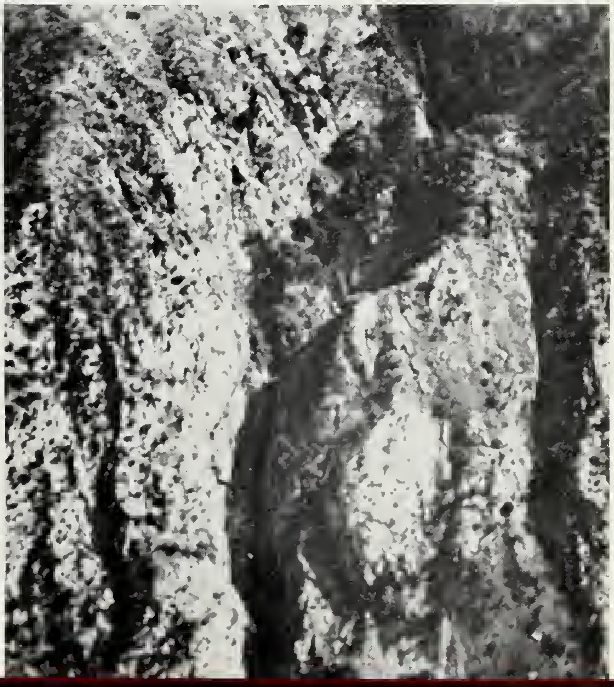


Figure 2.—Flood damage that originated from the 1958 Monkey Face Fire included more than 40,000 cubic yards of debris and buried portions of a State highway. The debris was washed from the burn (see below).



---

[4] Firetrol and Pros-chek are trade names for two long-term retardants based on di-ammonium phosphate and ammonium sulphate, respectively.

RAILROAD FIRES IN OREGON

JAMES B. CORLETT
Manager, Oregon Forest Protection Association

During much of American history, the great, puffing mainline steam locomotives pulled long lines of cars across the mountains, plateaus, and valleys of the West. In the woods, the old saddlebacks, Shay and Climax engines, pulled seemingly endless loads of logs to the tidewater mills, where lumber schooners paused in their voyages to the ports of the world.

However, these steam locomotives caused many fires along forest rights-of-way; therefore, many years ago the Oregon Legislature enacted laws regulating ashpans, screens, the water supply, and firefighting equipment. Some of these laws are still in force.

With the advent of diesel-burning locomotives, many protection people hoped that railroad fires would end. However, the new equipment became worn, lower grades of fuel were used, and equipment maintenance was not always optimum; therefore, railroad fires again became a major protection problem.

Railroad right-of-way fires on the forest protection districts of Oregon are increasing. For example, from 1954 through 1958, 3.2 percent of the yearly average of 828 man-caused fires on Oregon forests were railroad fires. However, for the 1,058 fires from 1959 through 1963, the percentage rose to 4.8. Incomplete statistics for 1964 and 1965 indicate that an even greater increase in the percentage of railroad fires can be expected for the 1964-68 period.

A recent report from 51 of the 402 rural and city fire departments of Oregon shows there have been 230 railroad right-of-way fires during 1965 in Oregon in nonforest protected areas. Of course, trains may not have caused all these fires. For example, some fires are caused by people throwing burning material from trains or smoking while walking along the tracks, or by youngsters playing with matches. However, most of these fires were caused by carbon sparks, brake shoes, hot boxes, fusees, dirty or faulty spark arresters, section gangs at work, etc.

Chip nets, right-of-way clearing, hotbox detectors, and lubricant and fuel oil research are being used by many railroads to reduce right-of-way fires. However, even greater emphasis on railroad fire prevention is needed. Protection organizations, legislators, and citizens unaware of these efforts have difficulty understanding why more has not been done.

Cooperation between the railroads and forest protection organizations in Oregon has been quite good. Reasonably good channels of communication have been established, and forest organizations have long had standard procedures for recovering costs incurred extinguishing railroad fires. The State forest laws contain provisions about the spread of fire to forests, and these laws have probably helped create the good working relationship between the railroads and forest protection agencies.

Railroad fires are especially difficult for small rural fire protection districts, many of which depend almost entirely on volunteer firemen. Because of inadequate finances, these men must often operate without adequate training, equipment, or protective devices. The recovery of railroad fire suppression costs by rural fire protection districts is complicated and confusing. In some of the newer rural fire districts, the volunteer firemen may not be fully informed about the Oregon fire laws. For example, railroad rights-of-way, rolling stock moving thereover, or improvements thereon are by law not included in rural fire protection districts unless the railroads consent to be included. However, the State Fire Marshal has authority to order the accumulation of any combustible material on any premises, including railroad rights-of-way, removed or the condition remedied. He also has authority to enforce such orders if necessary.

Some Oregon residents advocate the legislative approach to the problem of railroad fires. However, many have learned that legislation does not necessarily yield the most desirable or workable solutions to problems. It should be undertaken only after all possibilities for cooperative solutions have been exhausted.

In 1963, all fire organizations in Oregon—rural and city, private associations, State, and Federal—formed the informal Oregon Fire Action Council to solve fire problems through cooperative action. One major accomplishment of the Council has been to open channels of communication among all organizations concerned with fire prevention and control. All participants have learned that their problems are not unique and, through cooperative effort, solutions can frequently be developed. The Council believes that the railroads have a strong interest and stake in the prevention of railroad fires. Some make annual contributions to fire prevention programs. Others also contribute money, time, or training to

(Continued on page 16)

A WEATHER BRIEFING BOARD FOR FIRE CONTROL

D. John Coparanis, *Fire Weather Meteorologist*
U.S. Weather Bureau
Portland, Oreg.

Regional Dispatcher: "There's a lightning fire out of control in southern Oregon on the Fremont. I'll need to draw on some men and equipment from up north. What does the weather look like for the next 2 or 3 days in Washington?" This type of question is often heard in the Portland Fire-Weather Office during an active fire season. The Portland Fire-Weather Office is unique because it is a Weather Bureau facility in the Division of Fire Control of a Forest Service Regional Office (R-6). Therefore, Fire Control personnel can easily "tap the weatherman" for information.

Besides issuing daily fire-weather forecasts, the fire-weather meteorologist at Portland provides twice-daily briefings on Regionwide (Washington and Oregon) weather. The Regional Dispatcher attends these briefings and uses information received for both planning and operations. Additional briefings are sometimes provided for other Forest Service officials.

Some of these briefings are very detailed because the weather patterns cause a variety of weather effects over the forecast area. The details are difficult to remember 5 minutes after the briefings, especially when it becomes necessary to apply thse details to each of the 19 National Forests in the Pacific Northwest Region.

Therefore, a visual display board for the weather elements important to Fire Control was installed (fig. 1). The board consists of five parts:

1. Surface and upper air weather maps
2. Fire-weather forecasts from the six Fire-Weather offices: Portland, Salem, Medford, and Pendleton (all in Oregon) and Olympia and Wenatchee (both in Washington)
3. Regional map showing rainfall
4. Teletype copy of satellite bulletin
5. Regional map depicting forecast weather elements for each National Forest

The surface and upper air weather maps are received over the facsimile machine ready for display.

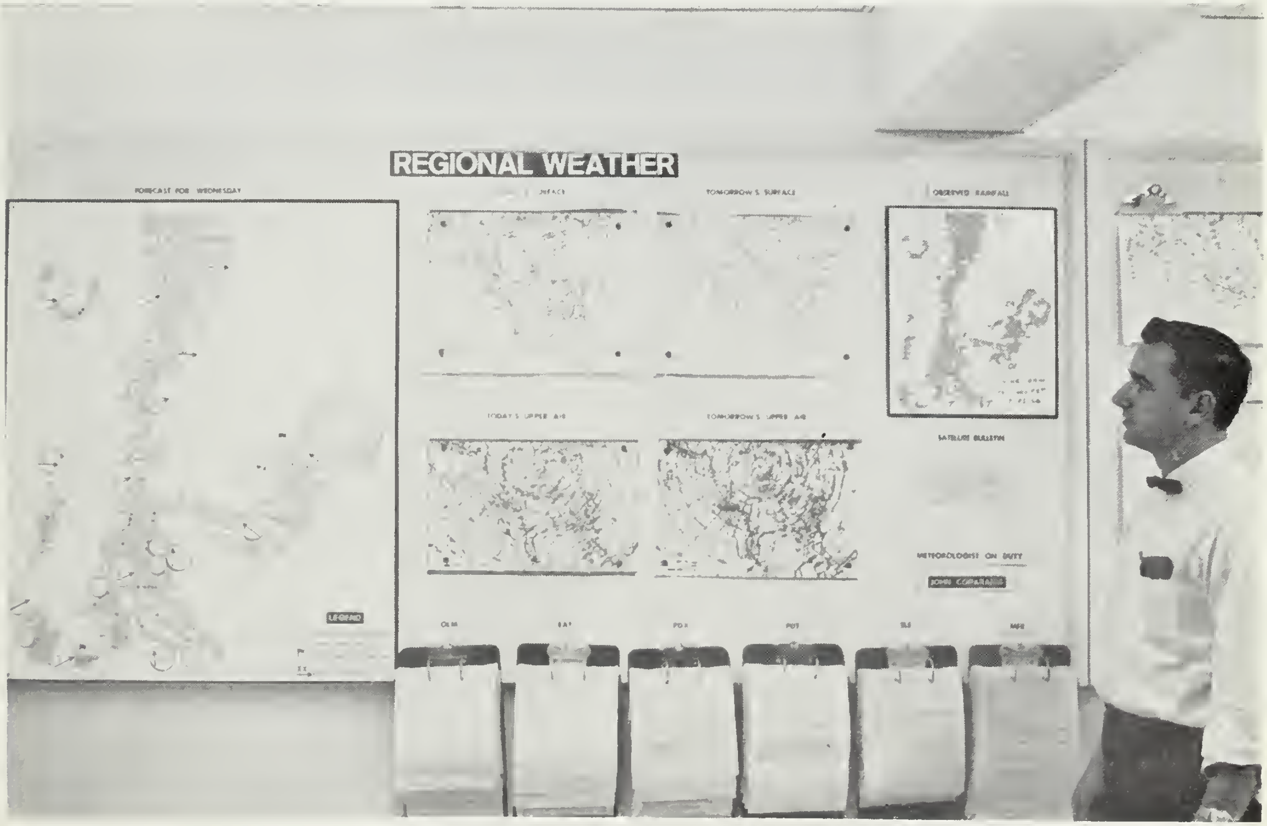


Figure 1.—This weather briefing board is at the Portland Fire-Weather Office.

These depict the weather patterns over much of the Northern Hemisphere both as they are observed "today" and predicted for "tomorrow." Use of these maps permits the three-dimensional characteristics of the atmosphere to be described.

Detailed fire-weather forecasts received at the Regional Office from the six Fire-Weather offices in the Pacific Northwest are posted on clipboards.

A small Forest Service Regional map is used to record rainfall. This information is important because it indicates the areas relieved from drought.

Environmental Science Services Administration satellite pictures of cloud cover over and adjacent to Oregon and Washington are received daily at the Weather Bureau Office in Seattle, Wash. These pictures are interpreted by meteorologists at Seattle and transmitted in plain language messages over weather teletype. This information is often included in the fire-weather forecasts to place emphasis on certain weather predictions.

A large Forest Service Regional map depicts forecast elements for each National Forest; color coded numbers are used (fig. 2). The forecast lightning probability is shown as a red number and the forecast minimum humidity as a green number. In addition, the forecast speed and direction of winds over ridges is shown for larger areas. All this information is extracted from the detailed fire-weather forecast. If a "Red Flag" forecast—one which calls attention to a weather condition of unusual importance—is issued by a Fire-Weather Office, a red flag tag is placed at the Fire-Weather Office's location. The metal rim tags with numbers are hung on permanent small pins (two per Forest). These tags are easily changed so the board can be kept current. The wind tags can be hung on pins or temporarily taped anywhere on the base map to show the general windflow over a large area.

Figure 2 graphically shows a special fire-weather condition. As can be seen by the wind direction arrows posted, southerly winds aloft are entering southern Oregon. In the summer in the Pacific Northwest, these winds have a high correlation with widespread thunderstorm activity. Consequently, a high probability of lightning (60-80 percent) is forecast for most Oregon Forests. Minimum humidities predicted for this same area are 10-20 percent. These conditions have prompted two Fire-Weather Offices, Medford and Pendleton, to issue "Red Flag"

(Continued on page 16)

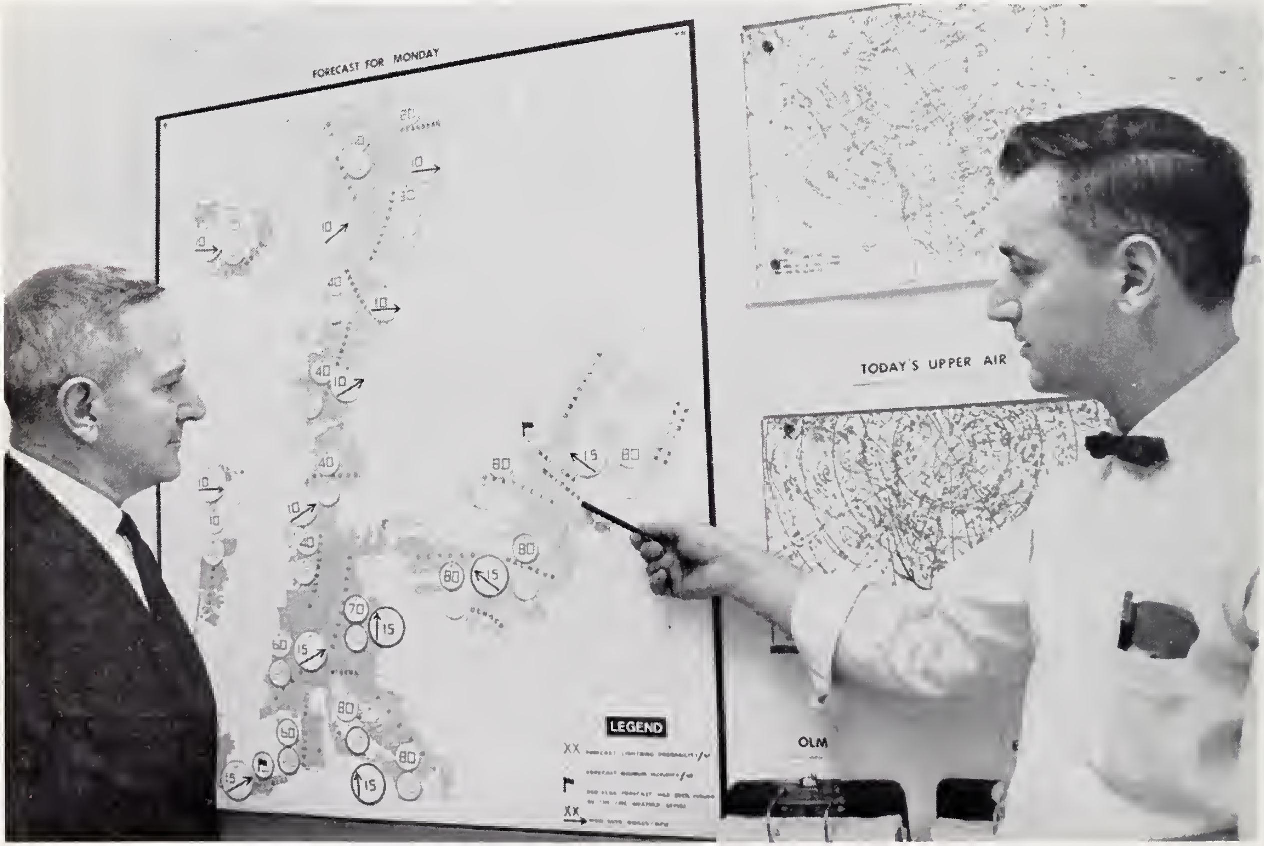


Figure 2.—This Regional map visually depicts important forecast fire-weather elements.

A MODERN DISTRICT WAREHOUSE

Donald H. Marriott
Fire Control Officer, Trabuco District
Cleveland National Forest[1]

The fire warehouse on the Orleans District, Six Rivers National Forest was recently remodeled to provide a modern facility for the efficient handling and storage of equipment and supplies.

Major changes in the structure included removal of all windows to permit better utilization of wall space and to reduce maintenance and cleaning costs. Also, all partitions, closets, and panels not needed for building support were removed. These changes have facilitated movement of supplies in and out of the building, and permit a quick inventory of all fire equipment. The original two 32-inch doors and one heavy sliding door were replaced by three 10-foot aluminum overhead doors. Incandescent light fixtures were replaced by daylight-type fluorescent lighting. Porch lighting was similarly improved, and night loading is now very safe.

Shelf storage 8 feet high and 2½ to 3 feet deep has been constructed along the entire 46-foot rear wall. Metal lettering strips like those used in supermarkets are fixed onto each shelf, and the name and inventory count of items on each section are shown. A rolling ladder provides quick access to the upper shelves (fig. 1). Handtools are stored in two racks similar to those shown in an earlier Fire Control Notes article.[2]

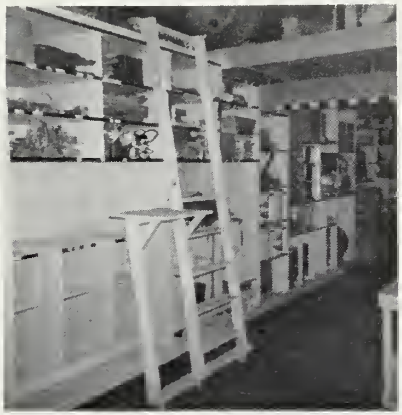


Figure 1.—This ladder provides safe access to items stored on upper shelves. The attached table holds material while a man climbs down.

Open bins on both sides of the stairway hold smokechaser equipment where it is readily accessible and easily inspected. The space under the stairs was closed off and is used for storing brooms, mops, and other maintenance supplies. A screened, rodent proof room was built to provide storage space for radios, batteries, blankets, and fusees. A separate lock is used on this room.

A hardboard flooring surface permits easy movement of the individual castered pallets on which all floor cache boxes are stored, and the entire fire equipment inventory can be moved onto trucks by one person. Also, all equipment on the ground floor can be quickly wheeled back behind the stairway to make a 30- by 26-foot area available for meetings and training sessions.

The second floor is used primarily to store project tools and equipment. Bulky or heavy items are moved to and from this area by a stair lift. This consists of a small 110-volt electric winch which pulls a wheeled platform on rails up the stairway (fig. 2). This type of lift was selected instead of a cage elevator to save floor space on both levels. The winch housing is built against the rafters, where lack of headroom prohibited storage.

The docking facilities are able to accommodate five vehicles at one time. Either side or rear loading is possible at two of the three bays. A removable chain railing guards all dock edges.

Savings in man-hours spent handling equipment and supplies during the next 5 years are expected to pay for the remodeling of the warehouse. Also, since inspection of tools and supplies can be more easily carried out because they are readily visible, maintenance of the fire cache will be improved. A third and important benefit of the facilities is safety—equipment is handled by units, and lifting and carrying is not needed.

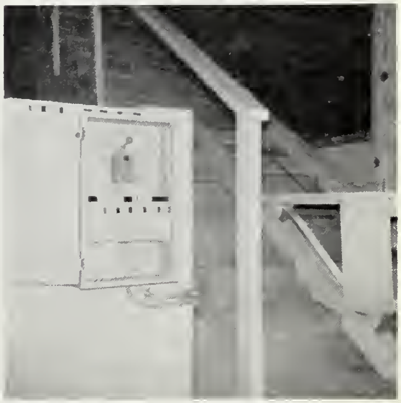


Figure 2.—View of stair lift and control panel is shown. When not in use, the lift platform is pulled up out of the way under winch at head of stairs, and rails fold up along far edge of stairway.

---

[1] Former Fire Control Officer, Orleans District, Six Rivers National Forest.

[2] Region 4, Forest Service, USDA. Care and storage of handtools. Fire Control Notes, vol. 24, No. 4, October 1963, pp. 99-100, illus.

MARKING PERMANENT HELISPOTS WITH FIBERGLAS PANELS

P. A. Theisen, *Forester*
Siskiyou National Forest

An inexpensive, prefabricated marking system which requires little maintenance was developed on the Siskiyou National Forest in southwest Oregon. The markers identify permanent helispots developed for multiple use management (fig. 1.).

The helispot marker is made from yellow corrugated Fiberglas panels, which are readily available from local building suppliers. Other high-visibility colors are also available.

Panels are cut to specifications (fig. 2) and drilled for 3/8- by 10-inch spikes driven into the ground to anchor the panels. Rubber or plastic washers can be used between the spike head and the Fiberglas to prevent the panel from being pushed past the spike head if frost heaving is likely to occur. Identification letters and numbers are painted on the base panel with black polyurethane paint. The sides of four triangles can be cut from a 10-foot-long panel of Fiberglas 26 inches wide. Three bases can be cut from a 12-foot by 26-inch panel.

The Fiberglas and 14 spikes needed for one helispot marker cost approximately $3.27.

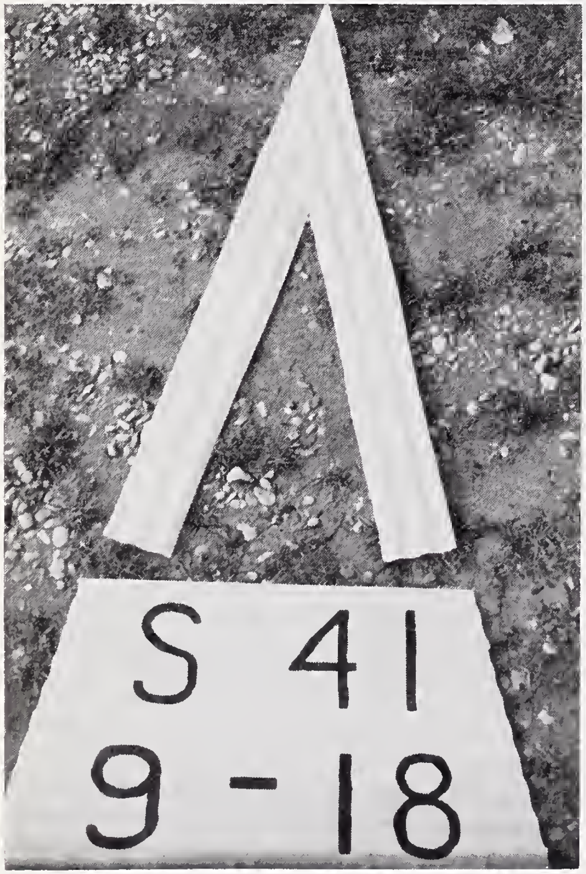


Figure 1.—A completed marker for a permanent helispot is shown.

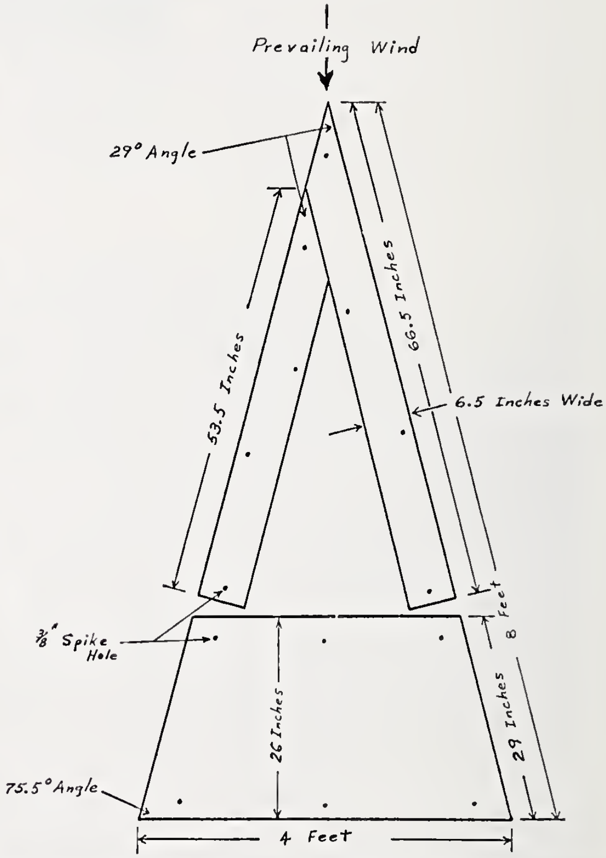


Figure 2.—Diagram of Fiberglas panel used to mark permanent helispots.

THE RELATION OF SPREAD INDEX TO FIRE BUSINESS IN CONNECTICUT

JOHN J. KEETCH, *Forester*
Southeastern Forest Experiment Station

The State of Connecticut has used fire danger measurements to plan their fire prevention and other fire control activities for more than 25 years. In 1964, the spread tables of the National Fire Danger Rating System were adopted; they replaced the type 8 Burning Index meter used since 1954. This article examines the relation between spread index and two easily measured aspects of fire business—number of fires and number of acres burned by size class. Connecticut was selected for this study because it has a heavy fire load and an active fire control organization. Also, the State started using the spread index a few months earlier than other States.

The Connecticut State Park and Forest Commission is responsible for protecting about 2 million acres of forest and woodland from fire. This task is particularly difficult because the State is fourth in population density (517 people per square mile according to the 1960 census). The cause of fire is related to this high population density. During the 1954-63 period, 98.2 percent of the State's fires were man-caused.

In 1964, 943 fires burned 3,566.6 acres. The percentage of man-caused fires was the average 98.2, but the total number and acres burned were 50 percent greater than the average for the previous 10 years. This relatively high rate of fire activity provides a good basis for evaluation of the effectiveness of spread index and its relation to fire business.

By definition, the spread index is a number (on a 100-point scale) indicating the relative, not actual, rate of forward movement of surface fires. The spread index value is an abstract number until it is related to the local conditions of a fire protection unit. But reliable data on free spread of wildfire are seldom recorded. Therefore, fire business items related to spread that *are* recorded must be considered; these include the distribution of fires and acres burned by size class. This information is immediately useful in interpreting and applying the spread index in local fire control preparedness planning.

Fire data for this study were obtained from code sheets prepared by the State for the annual Forest Fire and Forest Fire Danger report. Daily spread index values were read from fire danger records prepared at four fire danger stations operated by the State and at one station operated by the U.S. Weather Bureau.

Fires may occur on almost any day in the year, but they usually are not distributed evenly. Fires are concentrated in the spring and fall because burning conditions are more severe and because fire-starting agents are more active.

In 1964, more than 90 percent of the fires and 94 percent of the burned acreage occurred during the spring (March-May) and fall (September-November). This distribution of fires and acres suggested that a two-part grouping of the data might be most useful to identify the general relation of spread index to fire business. Accordingly, in tables 1 and 2, spring and fall fires are combined to represent the fire season; summer and winter totals indicate off-season trends. The ranges of spread index in units of five provide a finer breakdown than is normally used, but the added detail improves clarity.

Since the two seasons were equal in number of days, factors other than time must account for the unequal fire experience between them. The factors contributing to the difference are numerous, but they may be broadly grouped into those bringing changes in: (1) Relative risk, (2) ignition potential, (3) rate of spread, and (4) effectiveness of control effort. The spread index obviously provides only a portion of the information needed to equate fire danger and fire business in the State. Nevertheless, until more refined tools are available, such as an index related to ignition, the spread index may be used as a general guide.

It is clear that fires did not have an equal opportunity to start and spread in the fire season and in the off season (table 1). In the off season there were only 11 days of spread index 15 or more; there were 94 such days in the fire season. Also, in the lowest four spread index ranges, where both seasons were represented, average fire incidence per day in the fire season was two or three times the rate in the off season. This comparison indicates that the activity of fire-starting agents is greater in the fire season by a ratio of 2 or 3 to 1. In turn, this ratio suggests that a given level of preparedness is needed at a lower predicted spread condition in the fire season than out of season.

TABLE 1.—*Number of days, fires by size class, and average fires per day, by spread index range, Connecticut, 1964*

FIRE SEASON

Spread index	Total days	Total fires by size class			Average per day (all fires)
		0-9.9 acres	10.0-99.9 acres	100+ acres	
0-4	28	6	0	0	0.2
5-9	18	24	1	0	1.4
10-14	43	111	9	0	2.8
15-19	36	190	8	0	5.5
20-24	34	211	22	1	6.9
25-29	15	145	13	1	10.6
30+	9	95	11	3	12.1
All	183	782	64	5	4.7

OFF SEASON

0-4	98	13	0	0	.1
5-9	48	26	0	0	.5
10-14	26	22	4	0	1.0
15+	11	27	0	0	2.5
All	183	88	4	0	.5

The distribution of fires by size class in table 1 reflects the potential for fires to spread faster as the spread index increased. The bulk of the fires were held below 10 acres regardless of spread index, but holding down the size apparently became more difficult as the index increased. During the fire season, about one fire of more than 10 acres occurred every 4 or 5 days in index range 10-14, about 1 per day in index range 25-29, and more than 1 per day at index 30+. Fires of 100 acres or more appear at index 20-24, but most (3 of 5) occurred during the 9 days when the spread was 30+.

Presumably, fire preparedness was increased as the potential for fires to spread increased because most fires were contained at a small acreage. The largest fire reported was 250 acres. But evidence that the task became more difficult as spread index rose is indicated in table 2. Below index 20, only 43 percent of the acres burned were by fires of more than 10 acres in final size. Above index 20, this percentage rose to 68. In the top spread range, the larger fires accounted for 78 percent of the total burn. Certainly factors other than those indicated by spread index were involved; such factors included topography, elapsed time, and local fuel concentrations. But the record does indicate a strong trend for fires to become harder to handle as the index climbs.

The consistent increase in average fire activity with each rise in the level of spread index reflects the greater opportunity for fires both to start and to spread as the index rises. Average occurrence in the fire season climbed gradually from about 1 fire every 5 days in the lowest spread range to about 12 fires per day in the top spread range (table 1). A similar increasing trend in the area burned on an average day is indicated in table 2.

In summary, while the figures in the tables are averages, the continuous uptrend in the average daily fire business indicates a potential change in average fire load that should be extremely useful to fire officials in interpreting and applying predicted spread index in preparedness planning. The values reported here apply only in Connecticut, but similar trends may be expected in other areas where man-caused fires are of major concern.

Table 2.—*Number of days, acres burned by size class, and average acres burned per day, by spread index range, Connecticut, 1964*

FIRE SEASON

Spread index	Total days	Burned area by size class			Average acres burned per day (all fires)
		0-9.9 acres	10.0-99.9 acres	100 acres+	
0-4	28	4.2	.0	0	0.2
5-9	18	31.7	18.0	0	2.8
10-14	43	180.6	183.0	0	8.5
15-19	36	273.6	170.0	0	12.3
20-24	34	374.1	550.0	120.0	30.9
25-29	15	227.1	227.0	100.0	36.9
30+	9	194.7	227.0	466.0	98.6
All	183	1,286.0	1,380.0	686.0	18.3

OFF SEASON

Spread index	Total days	0-9.9 acres	10.0-99.9 acres	100 acres+	Average acres burned per day (all fires)
0-4	98	16.4	0	0	0.2
5-9	48	33.5	0	0	.7
10-14	26	30.2	80.0	0	4.2
15+	11	54.5	0	0	5.0
All	183	134.6	80.0	0	1.2

CHILDREN WITH MATCHES

National Wildlife Federation Conservation News

Berkeley, Calif. Would you believe 92 percent of the forest fires started by children playing with matches are set by boys (not girls)? It's true, at least in the Angeles National Forest where the University of Southern California made a study of that problem for the U.S. Forest Service. Would you believe that 5-7-year-olds set most of the fires studied? That's true, too. Dr. William S. Folkman, a sociologist doing research on forest fire prevention, said the Angeles National Forest was chosen for the study because it is representative of a problem now developing all over the United States—increased residential development and higher human populations at the fringe of wildlands.

***Air-Attack Base*—Continued from page 5**

4,000-square-foot quonset building is at the corner of the aircraft area; it provides space for the office, readyroom, shop, and warehouse. Two F7F airtankers under Forest Service contract are stationed at the base. At least one B-17 is expected to be available in the future.

The Loma Rica base is operated jointly by the California Division of Forestry and the Tahoe National Forest. Work schedules and safety and operating plans are developed and approved by both agencies, and operational costs are shared.

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

OFFICIAL BUSINESS

U.S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

Slip-On Forest Fire Tanker—Continued from page 4

However, Service-wide demonstrations are needed to inform fire control personnel of end mounting and other new or changed equipment designs. The San Dimas Equipment Development Center has selected titles for slip-on tankers for Service-wide use. The Center has distributed much needed information about new equipment and become recognized as a source of technical assistance.

Region 5 has sponsored and financed the development of prototype tankers incorporating many design features which have Service-wide application. The R-5 ground tanker committee has kept experienced firemen informed of slip-on tanker development at the Center. Regions 6 and 9 have also been leaders in the use of water equipment in forest fire control. The design of slip-on tankers has been influenced by every Forest Service Region.

Two primary advantages will result from the Slip-On Tanker Updating Standardization Project. One will be completion of Service-wide specifications for popular-size tanker outfits, and another will be development of standard Forest Service plumbing drawings for qualified pumpers. Purchasers will be able to select and match tanks, pumpers, and reel or tray and have them assembled by qualified contractors.

Slip-on tanker purchases planned during the 1964-69 period include 260 small (50-80 gallon), 165 medium (100-250 gallon), and 40 large (over 250-gallon) units (fig. 3). The 50-, 75-, 125-, and 200-gallon tankers are expected to be the most popular in the future.

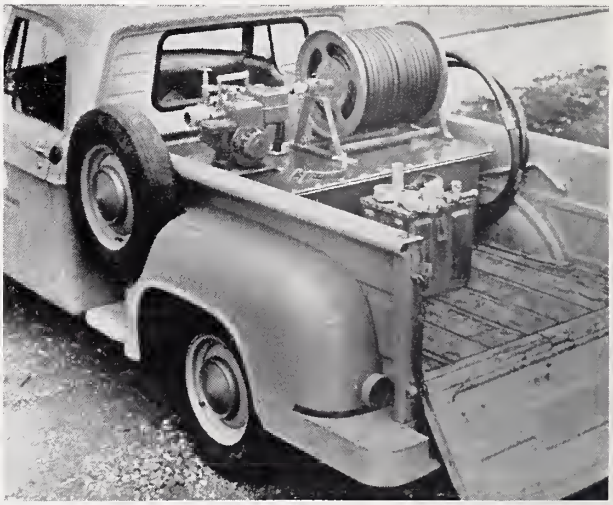


Figure 3.—An 80-gallon slip-on unit with a Fiberglas tank is shown. These tanks are lighter than metal, and allow more water to be carried.

Weather-Briefing—Continued from page 10

forecasts. Lower probabilities of lightning, and generally higher humidities, are predicted for the other Forests in the region.

The Division of Fire Control is very enthusiastic about the weather briefing board. During the fire season, it is posted twice a day to coincide with the twice-daily fire-weather forecasts. The day of the week for which the forecast is valid is posted above the large Forest Service base map.

Railroad Fires—Continued from page 8

other prevention programs, both in and out of the railroad organization.

However, the problem of railroad fires needs additional serious study, and the Council has invited representatives of the Oregon railroads to join in its deliberations and efforts. The protection organizations are confident that, by working together, the many problems connected with railroad fires can be better clarified. Cooperative solutions can be developed which will benefit all parties concerned.

eserve
1
= 766Fi

FIRE CONTROL NOTES

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

AUG 1 8 1967

CURRENT SERIAL RECORDS

U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/JULY 1967/VOL. 28, NO. 3

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Page

3 Problems in Establishing Fire-Weather Stations in Alaska
F. D. Paxton, R. M. Bowman, and C. D. Johnson

4 A Lookout Cargo Winch
Missoula Equipment Development Center

4 Balloon Drop
James C. Larkin

5 Fire Danger Computers
Frank E. Lewis

6 The Helicopter—An Effective Fire-Prevention "Tool"
Division of Fire Control, Region 9

Page

7 Disposing of Slash, Brush, and Debris in a Machine-Loaded Burner
Harry E. Schimke and Ronald H. Dougherty

10 Arson in the Forest
Edwin R. Outlaw

11 A New Tool for Slash Disposal
Robert L. Asher

12 Spark Arresting Mufflers for Powersaws
Washington Office Division of Fire Control

13 A Fire Tool Supply Trailer
Milo R. Drilling

16 Electronic Display for Fire News
Merle F. Pugh

COVER—The Clark National Forest (Missouri) prevention helicopter is shown scouting a small fire. Such early arrivals deter incendiarists and permit early warnings to be given to legal burners. On wildfires, the two-man crew can usually handle the initial attack. See story on page 6.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

PROBLEMS IN ESTABLISHING FIRE-WEATHER STATIONS IN ALASKA

F. D. Paxton, R. M. Bowman, and C. D. Johnson[1]

The role of the Fire-Weather Forecaster in Alaska in the early detection and control of lightning-caused fires is fairly new. However, the value of the forecasting assistance provided by the Weather Bureau to the Bureau of Land Management is clearly recognized.[2] But more stations in remote areas are needed to intensify the observation network and thereby strengthen implementation of the National Fire Danger Rating System.

Many interesting problems may be encountered in establishing a new fire-weather observation station in Alaska. The State's vast area and sparse population provide a serious obstacle to adequate weather sampling. There are two primary requirements in the selection of new sites. They must fill a void on the meteorologist's map to assist in the early detection of critical lightning storms, and, more important, someone must be available to take observations.

In 1965, one suitable site was selected at Stevens Village, a settlement of about 80 Athabascan Indians 100 miles north of Fairbanks, on the Yukon River. Official reports had not been recorded at the village, but analysis indicated that the general area had a high incidence of thunderstorm activity. Therefore, it was necessary to establish an observation station in the locality. However, it could not be installed until early June because of the Yukon River breakup and subsequent flooding. Meanwhile, planning and logistics, while not extensive when compared to some Arctic area supply situations, consumed considerable time. Aircraft schedules were coordinated with other suppression and presuppression activities; equipment was purchased, and instruments were packed for the rugged trip by amphibious plane.

On the date of the trip (June 7), the waters of the Yukon, while not in flood stage, were still high. The current is particularly swift near the village as it weaves through a maze of islets and across bars. The banks at the village are steep and covered with black sand and clay. The pilot landed after he was certain that there were no visible snags or obstructions which would endanger the aircraft. Soon he was able to pull the craft far enough upon the bank to unload. Interested villagers lined the bank to watch. The Chief of the village was immediately contacted, and a potential native observer was soon interviewed.

Shortly thereafter, selection of a proper instrument exposure site was begun. A narrow grassy area in the center of the village was not usable because of the nearness of the buildings and traffic. Since the buildings were located upon the highest ground close to the river, and a shallow slough surrounded the backyards of the log houses, the rear area of the log house cluster was also unacceptable. A path went across the slough and through a heavy brushy stand of willow, white birch, and alder to a small dirt airstrip, still unusable due to mud, about 800 yards from the village. Because the trees were tall, a site too near the runway could not be used, for the anemometer tower would be a hazard to incoming aircraft. A site along this path, about 300 yards from the village, was finally chosen.

Four men from the village were hired to clear an area approximately 130 feet square. Disposal of the brush was not difficult—it was piled in rows along the outside edges of the clearing. After these windrows are cut about every 5 feet with chain saws and left in the summer sun to season, this wood becomes a readily available source of winter fuel for the villagers and will soon be used in their stoves.

Before the instrument shelter, the rain gage, and the anemometer were erected, it was necessary to remove roots and debris, and to level a 16- by 16-foot area near the center of the clearing for the instrument enclosure. The first blow of the pulaski firefighting tool hit permafrost. All digging and leveling had to be accomplished in the frozen subsoil. The dislodging of roots and stumps in permafrost is, at best, difficult, but here the problem was greater because the shade of the brush and the duff covering the ground had prevented even a superficial permafrost retreat. To provide for the leveling of the shelter, pulaskis were used to chop into the dirt and ice. To measure the true wind at the site, the anemometer had to be placed 20 feet above the average height of the surrounding brush. This required a 50-foot tower, which

Continued on page 14

---

[1] Paxton is a Fire Weather Forecaster, Weather Bureau, Environmental Science Services Administration, U.S. Department of Commerce. Bowman is Unit Manager, Ft. Yukon Administrative Unit, and Johnson is Fire District Supervisor, Fairbanks District and Land Office. Both are employed by the Bureau of Land Management, U.S. Department of Interior.

[2] Paxton, F. D., and King, L. D., Sky fire in Alaska—Summer 1964, Fire Control Notes, v. 26, No. 2, April 1965, pp. 6-7.

A LOOKOUT CARGO WINCH

Missoula Equipment Development Center

A hand-operated winch for raising and lowering cargo between the ground and the catwalk of a fire lookout tower has been designed at the Missoula Equipment Development Center. The design meets the following requirements:

1. Capacity of 200 pounds.
2. Ability to handle loads of at least 3′ by 3′ by 3′.
3. Capacity for 75 feet of cable.
4. Locking device to keep boom from swinging while a load is raised.
5. Breaks.
6. Rapid unwind system for returning empty hook to ground.
7. Safe and simple operation.

A prototype model was extensively tested during construction of a new lookout on Blue Mountain on the Lolo National Forest, Mont. The model was used to raise materials for the cupola (fig. 1).

While the winch was designed primarily for use on Region 6 style lookout towers, it is adaptable with minor modifications to other tower designs. However, some older lookouts lack standards, and custom modifications would be needed.

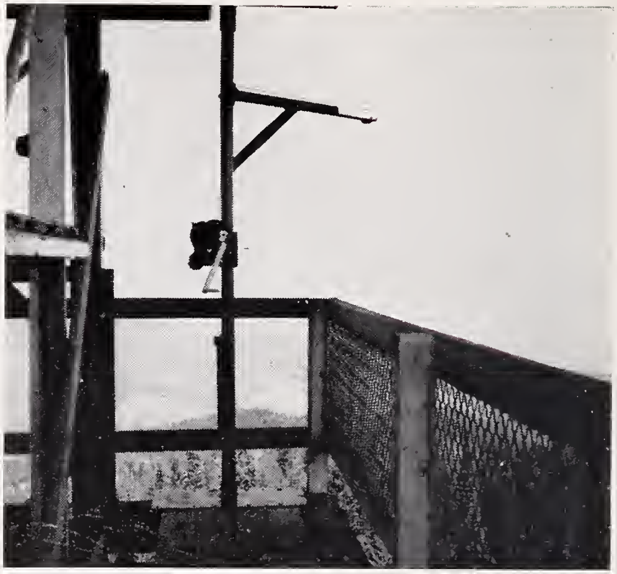


Figure 1.—View of winch installed on a lookout tower catwalk.

Cost of the winch when produced singly or in small quantities is about $150. Fabrication drawings are available from the MEDC.

BALLOON DROP

James C. Larkin, Western Zone Air Officer, Region 4

During early September 1966, the Payette National Forest in Idaho was being plagued by a seemingly unending rash of lightning fires. The largest, the Flossie Lake fire, was burning on more than 5,000 acres of lodgepole pine in the remote Chamberlain Basin area.

Manning and supply had to be carried out by air, with the planes landing at a back-country airstrip located just south of the fire. Extensive use of the Forest Service C-46, three C-47's, and many smaller aircraft soon had 300 firefighters and their equipment on the fire. However, the dense smoke which blanketed the area made the job of supplying these men touch and go. Many trips by the planes were cancelled, or the aircraft turned back to McCall, because of almost zero visibility at the Chamberlain strip.

A light rain fell during the night of September 12. This proved a godsend to the firefighters, but compounded the supply problem. The next morning the airstrip was blanketed by a dense, 500-foot-thick layer of fog. Rations at the fire camp were short. Breakfast had been prepared in McCall, but there was little chance that the plane could land at Chamberlain before noon.

Fire Boss Reed Christensen radioed McCall: "Load up the Doug with chow, rigged for paradrop. We'll have something worked out by the time you get here."

We arrived over Chamberlain in the C-47 shortly after dawn. Floating above the fog was a string of fluorescent weather balloons. Airport Manager Gary White came on the airnet. "Make your drop on the balloons."

I made a pass and two bundles were kicked out. White reported, "Good! Next time correct a hundred feet to the right, and drop a little sooner!"

By the third pass we zeroed in on the target, our chutes landing "right on." Fifteen minutes later chow was on the table.

A gimmick fostered by 300 empty stomachs, yes, but also a demonstration of real initiative and one more note to add to the fire control story.

Editor's note:

Such low-level flights over fog or cloud cover should be carried out only in multiengine aircraft. Also, particular care must be exercised on the ground to designate the drop zone so that personnel and equipment are not endangered by the drop.

FIRE DANGER COMPUTERS

FRANK E. LEWIS, *Forester*
Forest Service Electronics Center

Can electronic computers be used by fire control managers to efficiently and economically calculate fire danger ratings? To provide an answer, in September 1965 an equipment development project was assigned to the Forest Service's Electronics Center, Beltsville, Md. Use of analog methods seemed feasible. A pilot model of a computer was designed and constructed by Fred Biggerstaff, an electronics engineer, and this development led to the fabrication of a test unit (fig. 1) now being demonstrated and evaluated.

The device is designed to perform most of the necessary calculations for determining spread index based upon the National Fire Danger Rating System. Four weather elements—RELATIVE HUMIDITY, DRY-BULB TEMPERATURE, WIND SPEED, and PRECIPITATION—are inserted by setting dials calibrated for each element. The BUILDUP from the previous day is also set to the proper value by use of a dial. An estimate of the appropriate HERBACEOUS STAGE is introduced by setting a switch at one of three positions. A three-position meter switch permits the following items to be read directly from the meters: FINE FUEL MOISTURE, FINE FUEL SPREAD INDEX, and DRYING FACTOR and, after the buildup dial has been repositioned to reflect the latter, ADJUSTED FUEL MOISTURE and TIMBER SPREAD INDEX.

One feature in the design of the first test model is a lighted display which uses appropriate colors to indicate FIRE DANGER CLASS. As constructed, it is linked directly to the SPREAD INDEX meter. Those rating systems that combine certain other factors with SPREAD INDEX to arrive at a FIRE DANGER CLASS would require a slightly different circuitry to provide a similar display capability. The estimated cost of producing such computers in volume is about $1,000 per unit, depending on the design refinements. Other approaches toward fire danger computers have been suggested as a result of developments to date.

A simpler, much less expensive, and essentially nonautomated electronic fire danger computer has also been proposed. Such a computer could be patterned after the "do-it-yourself" type constructed from high school science kits. Such computers usually operate on flashlight batteries and use inexpensive potentiometers and a simple electrical meter. As with slide rules, graphs, and tables, several successive steps would be required to obtain final answers. To perform one step in a series of calculations, two of the three potentiometers must be rotated and set to appropriately calibrated scales. Then the third potentiometer must be rotated until the null meter reads zero; at that position the answer for the particular step can be read from a suitably calibrated scale.

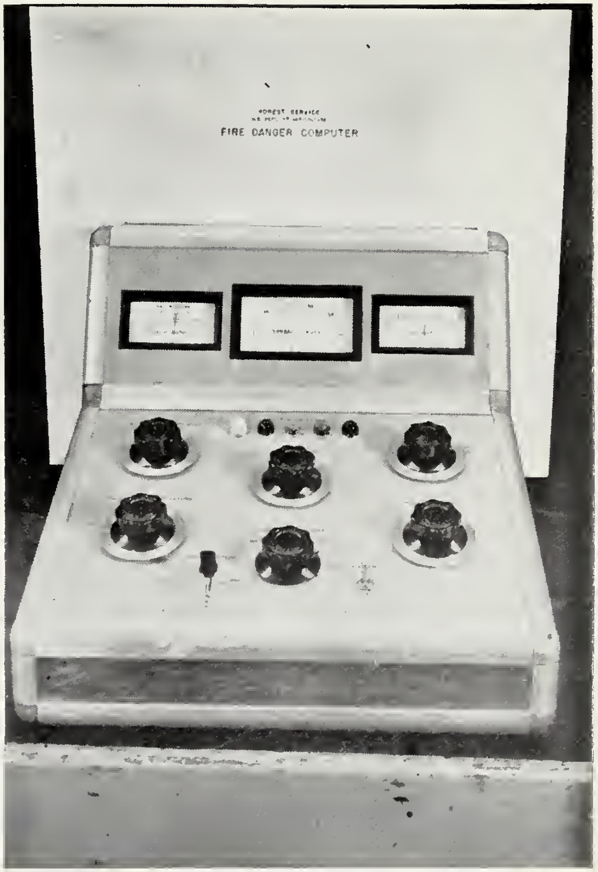


Figure 1.—Fire Danger Computer (Test Unit No. 1).

Computers are employed as research tools in the development and/or modification of various systems; one with a suitable design could serve a similar purpose for the National Fire Danger Rating System. A fire danger computer could be linked with suitable weather sensors via telemetry equipment and recorder equipment to provide fire danger data continuously or at preprogramed intervals. Such systems would, of course, require a computer design somewhat more sophisticated than that provided in the test unit. Suitable telemetry systems and sensors already exist.

Continued on page 6

Fire Danger Computers—*Continued from page 5*

Perhaps the greatest present potential for units such as the one being evaluated is for training. Such a device can clearly illustrate the relative effects of the various individual input elements, as well as some of the concepts represented by the various calculations. The same purposes cannot be accomplished as conveniently or effectively with pencil and paper, tables, graphs, and slide rules and meters.

Additional phases of the National Fire Danger Rating System are still being developed. While these aspects will be of great importance to fire control managers, they will further complicate the rating process. Use of electronic computers may be the best solution for performing all of the various operations which may ultimately be required. If rating systems become too cumbersome or too subject to errors in calculations, it would be best to use a computer at a central location to handle the rating process for individual rating areas. A suitable communication system would, of course, be vital to any such centralization of the rating job.

Meanwhile, the slide rule meter or a simple computer such as that described above may be the only items both sufficient and justifiable. Use of the more elaborate and automated systems, except for training or research, may not be practical now. It is increasingly valid for managers to obtain assistance in choosing the best alternatives for making decisions. Increasing importance attached to the values at stake and suppression costs will require application of all phases of modern technology to the protection job, including fire danger measurement and rating.

THE HELICOPTER—AN EFFECTIVE FIRE-PREVENTION "TOOL"

Division of Fire Control

Region 9

A different approach to fire prevention problems is being evaluated on the Clark National Forest in Missouri. Since the spring of 1966, a helicopter fire-prevention and initial-attack project (with emphasis on prevention) has been conducted on three ranger districts. The other districts are serving as control areas. The Clark has a history of a high rate of man-caused fires.

PLANNED OPERATIONS

A Bell 47 Super-G helicopter, which carries a pilot and two-man crew, is used. The aircraft has a radio and a 40-watt public address system.

Planned use of the helicopter during the fall and spring fire seasons totals 110 hours. This time is budgeted as follows: Fall, 30 hours for hunter prevention contacts and surveillance and 10 hours for smoke investigation; spring, 50 hours for smoke investigation and 20 hours for prevention contacts and surveillance. In their prevention work, the helicopter crew patrols areas of hunter concentration and works with ground patrolmen in making prevention contacts. During general surveillance or smoke investigation missions, the crew contacts landowners doing burning (fig. 1). They also conduct "hot" investigations on fires started by incendiarists, debris burners, hunters, and others, and they observe and pursue suspects.

The helicopter crew is used on initial attack only on fires where it has a definite advantage over ground forces. When the crew is used in initial attack or for scouting a going fire, it is relieved of fire duty as soon as possible so that the men may return to prevention work.

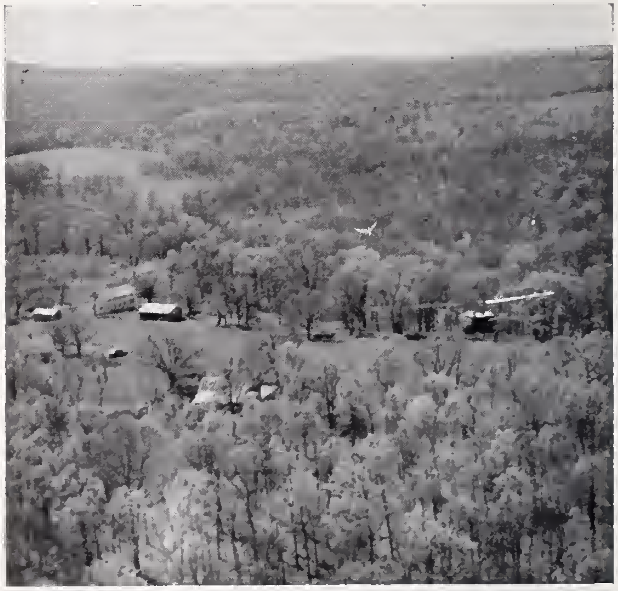


Figure 1.—"Controlled" fires of local ranchers that escape are responsible for one-third of the fires on the Clark National Forest. The helicopter crew can land nearby and advise the farmer on safe burning.

Continued on page 15

DISPOSING OF SLASH, BRUSH, AND DEBRIS IN A MACHINE-LOADED BURNER

HARRY E. SCHIMKE AND RONALD H. DOUGHERTY
Forest Fire Laboratory, Forest Service, USDA
Riverside, Calif.

Land managers continually seek better methods of disposing of slash, brush, and debris resulting from logging, thinning, and other clearing operations. The problems of disposal are many. When slash is dry enough to burn, burning in many cases is unsafe or difficult because of the control lines, constant watch, and mopup which are required. However, if weather conditions permit slash burning to be done safely, the material may not burn well; constant kindling, stoking, and chunking may be necessary. And sometimes slash will not burn at all. Of course, slash can be chipped, buried, or hauled away, but these methods are relatively expensive.

At times it is undesirable to "live" with the slash until conditions are right for burning by the usual methods. This is particularly true of slash left after road construction, or after the development of fuel-breaks or recreation areas. A method is needed to permit the burning of slash when it is created, regardless of its moisture content or weather conditions; this method must also cost less than other disposal methods.

Personnel of the Pacific Southwest Forest and Range Experiment Station developed and tested a portable slash burner. This unit is mechanically loaded and consumes slash as fast as it can be fed into the burner—regardless of how green or wet the material is. Burning can be done safely under all but the most hazardous burning conditions (fig. 1).

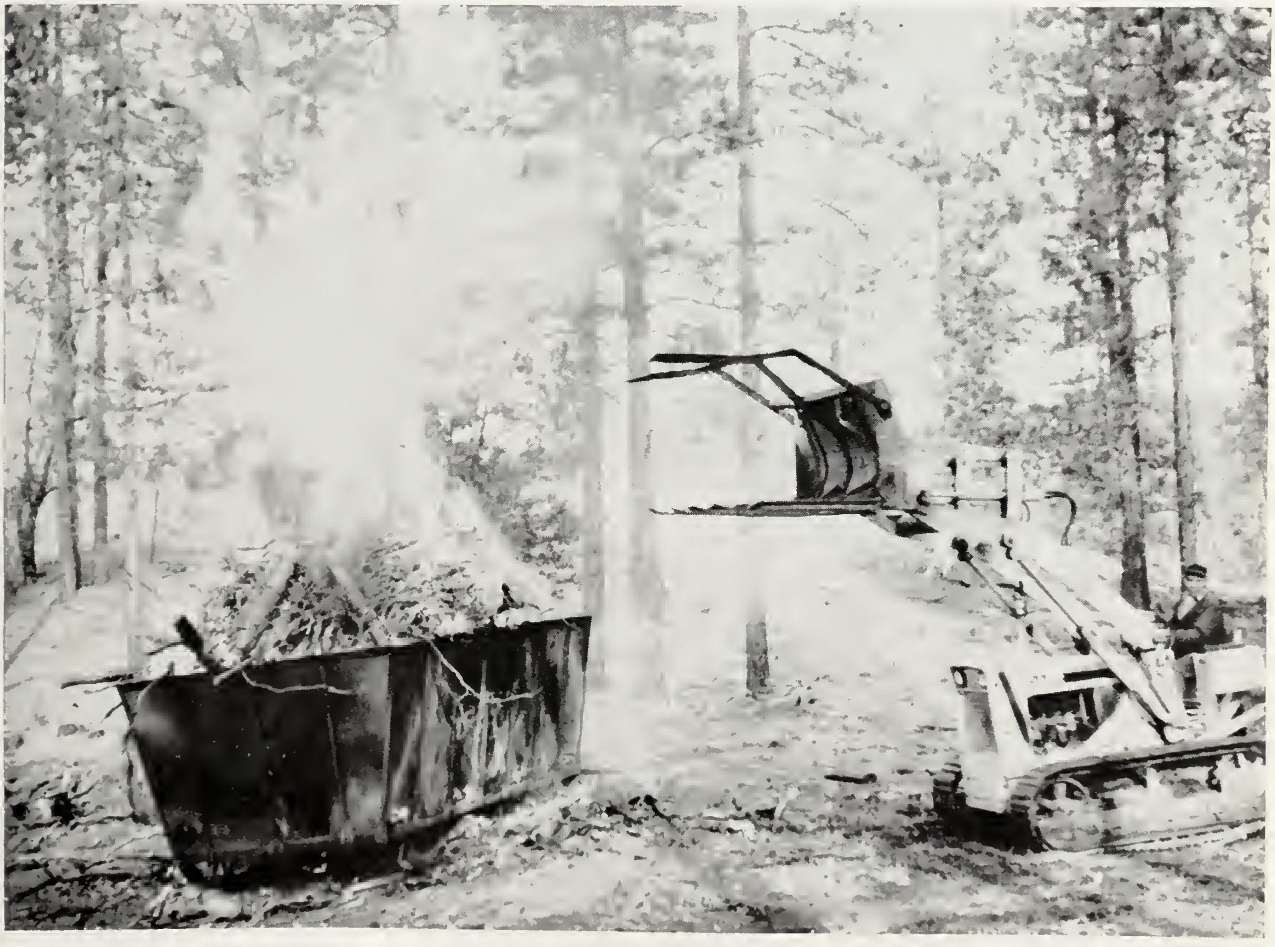


Figure 1.—Slash is hoisted into the burner box by this loader equipped with a specially constructed fork unit.

TEST CONDITIONS

The slash burning equipment was tested on six types of materials under various weather conditions. All trials were held early in 1966 at an elevation of 5,000 feet. The types of material burned during this test were:

1. Partly cured mixed-conifer slash resulting from fuel-break thinnings (hand-piled).
2. Small, green mixed-conifer sawlogs (cut and piled after fuel-break rethinning).
3. Cured mixed-conifer logging slash (as lopped).
4. Cured mixed-conifer slash and brush (piled by bulldozer during fuel-break construction).
5. Green mixed-conifer thinning-area slash (broadcast over the thinning area).
6. Green manzanita brush (bulldozed during land clearing).

Burning was done when it was raining, snowing, windy, calm, dry, and fair.

The burning was done in a confined unit; therefore, there was little danger of escape, and the operation was continued when open burning would not have been permitted owing to the danger of escape. More than 957 tons of material, an average of 9.2 tons per hour, were burned.

EQUIPMENT

The burner was an open-top, skid-mounted, transportable metal "box." It was 14 feet long, 6 feet wide at the base, and tapered outward to 8 feet at a height of 6 feet. The box was supported by 1-foot uprights on plow steel runners curved up on both ends. Fourteen-gage steel sheets were mounted to an angle iron frame on the sides and ends, with 1-foot holes at the base for a draft. The grates of the burner consisted of a channel iron frame supporting perforated airplane landing mats.

The loader was a small, 42-hp., crawler-type tractor with hydraulically operated, specially made front unit forks. None of the commercial forks were satisfactory for picking up slash. Therefore, Station personnel constructed a four-tined fork mounted to the backplate of the loading unit and a three-tined holddown fork which could be actuated by the hydraulic cylinder used to operate the loader bucket. The total unit weighed about 9,000 pounds and could lift and transport loads up to 2,000 pounds—a weight equal to that of a slash pile with a 7-foot diameter.

OPERATION OF BURNER/LOADER

One man could perform the entire operation. However, a swamper was kept with the unit—primarily for safety.

The loader pulled the burner into the slash area, unhooked it, and fed a couple of loads into the burner. After the load was ignited and began burning, the loader fed slash almost continuously, moving the burner as needed so the loader would not have to travel more than about 25 yards. Farther travel slowed the operation. The burner also had to be moved regularly to prevent a buildup of coals and ashes beneath the grates because such a buildup would reduce the desired air draft. And grates continuously embedded in coals would warp or burn out.

Slash which was not too wet was easily ignited with any conventional ignitor. For wet or green fuels, one or two discarded tires were used to get the fire going.

Sufficient coals usually remained in the burner overnight, and reignition was not necessary each morning.

More air was often forced through the burner with a wind machine to see if the addition of a blower system to the unit would be desirable. After numerous trials under various conditions, it was concluded that the added air, while accelerating the burning rate, was not needed. The fuels usually were consumed as rapidly as the loader could feed the burner.

The loader unit proved highly maneuverable and could work within close confines.

One phase of the test involved picking up unprepared material within a pine thinning area. The thinned trees had been sawed off and allowed to fall in place. Some thinnings were up to 25 feet long. Although considerable maneuvering was required, the material could be gathered and removed by the loader. But it was difficult to get the slash into the burner. If the trees had been bucked into 12-14-foot lengths and arranged in one direction, they could have been gathered, removed, and burned much more easily.

It was easy to pick up scattered logging slash where it lay. The forks were lowered to the ground, and the unit was moved through the slash deposits. When the forks were full, the load was delivered into the burner. The same procedure was followed in clearing slash and debris on roadsides.

Another phase of the test involved loading and burning green manzanita brush as it was cleared by a bulldozer. This material burned very hot and rapidly. A larger burner would be required if much brush of this size were to be burned. Because of its size and shape, manzanita brush usually would hook onto the sides of the burner and not fall completely into the fire.

COSTS

Average hourly costs for slash disposal follow:

End loader, crawler type	[1]$2.00
Operator	[2] 3.26
Swamper	[3] 2.71
Burner	[4] .31
Total	$8.28

[1] Based on Forest Service WCF equipment rental rates for FY 1966.

[2] Based on 1966 GS-7 salary.

[3] Based on 1966 GS-5 salary.

[4] Initial cost of $800 amortized for 4-year period (based on annual use of 8 hours per day, for 20 days per month, and for 4 months).

The cost per hour per ton ($0.90) compares favorably with other methods of slash disposal, and it is cheaper than most methods. Disposal by piling and burning cost $1 per ton, where there were 15 tons of slash per acre.[1] In studies of slash disposal in the central Sierra mixed-conifer type,[2] burying slash cost $1.76 per ton and chipping $2.77 per ton.

DISCUSSION

The method of slash disposal described in this article can be adapted to most situations. However, use of the loader is limited in steep, rocky, or dense-growth areas.

For most burning jobs, the largest burner that can be transported legally on a 1½-ton truck should be used. Such a unit could be 18 feet long, 8 feet wide, 7 feet high, and have a minimum clearance of 18 inches between the grates and the ground. A larger unit could be designed for logs, stumps, or other large material, but this would require special transportation equipment (tilt bed, low boy, etc.). The sides of the unit should be vertical so the slash load will bear directly onto the fire bed and grates and not onto the sides. To prevent the grates and frame from sagging, the runners should be placed well in from the sides so they will support the slash load directly. The unit should be equipped with a stiff hitch to prevent the burner from overrunning the loader when traveling downhill. The steel used in building the unit should be of heat-tolerant firebox plate. Its cost is slightly higher than that of mild steel.

The 40-hp. crawler loader proved a satisfactory companion for a burner of this size. The loading unit should have six forks, each 5 feet long, spread over an 8-foot width. It should be made of spring steel heavy enough to withstand all stresses encountered. Three holddown forks, made of the same material, are sufficient. A plastic shield should be provided to protect the driver from the intense heat of the fire.

With this loader-burner combination, slash volumes of about 200 cubic feet can be cleanly picked up with one pass. Once a loading technique is developed, production rates of 10 tons per hour can be expected.

Owing to the high burning temperatures and combustion efficiency maintained, little smoke was emitted. Little spotting occurred because the material that normally develops firebrands was rapidly and completely consumed. Because the fire was always contained, the need to care for many fires, as in pile burning, was eliminated. Therefore, there was no need to place lines around numerous pile fires, chunk and patrol, or extinguish them. If conditions require the burning to be shut down, it is easy to extinguish the burner fire.

---

[1] Unpublished fuel-break construction costs on file at the Stanislaus National Forest, U.S. Forest Serv., Sonora, Calif.

[2] Schimke, H. E., and Dougherty, R. H. 1966. Disposal of logging slash, thinnings, and brush by burying. U.S. Forest Serv. Res. Note PSW-111, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif., 4 pp.

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double spaced. The author's name, position, and organization should appear directly below the title.

Articles covering any phase of forest, brush, or range fire control work are desired. Authors are encouraged to include illustrations with their copy. These should have clear detail and tell a story. Only glossy prints or India ink line drawings can be used. Diagrams should be drawn with the page proportions in mind, and lettered so as to permit any necessary reduction. Typed captions should be attached to the illustrations, or included in the text following the paragraph in which they are first mentioned.

ARSON IN THE FOREST

Edwin R. Outlaw, *Criminal Investigator*
Ozark-St. Francis and Ouachita National Forests

Arsonists are hard to apprehend, so it is a great day in the life of a criminal investigator when he is able to obtain a confession made freely and openly. This happened recently to the author, when a young man, who we'll call John Thomas, admitted setting several fires.

The story began on a Monday in early March when Thomas reported a fire to Forest Service personnel and then helped suppress it. The fire was on private land, immediately adjoining National Forest land, and burned 28 acres. The same night another fire burned itself out, destroying an old house. Two days later, nearby fires were extinguished, again after being reported by Thomas, who had smelled leaves burning. District personnel noted that Thomas had reported each of the fires. On Friday the situation really became difficult. Thomas reported that he had been wounded in a gun battle with arsonists.

I immediately contacted the county sheriff, who had made a preliminary investigation of the shooting. He stated that while he could not obtain evidence, he thought Thomas set the woods on fire and shot himself to make it look good.

Thomas was called in for an interview. He told me how he had helped put out the fires. He also said that on Friday night, he went over the ridge and saw two men setting fire to the woods. He fired at one of them, and they began to run, shooting at him as they fled. He returned their fire, and believed he hit one man, as he heard him grunt. Part of our conversation follows:

"The other man turned around and started shooting at me, and the stock of my rifle probably saved my life. As it was I got hit in the leg with a bullet."

"Could you describe either man?"

"No, they were running away from me, and I didn't get a good look at them."

"Do I have your permission to make laboratory tests of the revolver and rifle?"

"Sure, and if you want me to, I'll take a lie detector test."

The State Police obtained a .22 revolver, the rifle, and Thomas' trousers, minus a swatch mysteriously cut from one leg, and sent these items to the FBI laboratory for tests. The examination disclosed that the right side of the front portion of the stock of the rifle had been damaged by a projectile about 0.23 inch in diameter. The damage was the same as that produced by a small caliber bullet fired at close range and traveling at a relatively low velocity.

When this report was obtained from the FBI, I went to reinterview Thomas, but he had vanished. I then visited his girlfriend, and she said he was working in a nearby city. When I told her I wanted him to take a lie detector test, she was surprised for she thought he had taken one. She said she would help me locate him. On Saturday night, March 26, the girl called me and said Thomas was ready for a telephone interview. He promised to meet me on Monday the 28th. However, he didn't appear for this interview or for a second one arranged for April 11th.

He had left the area, according to the county sheriff, who told me that he had a warrant for Thomas' arrest on a charge of issuing a bad check. He said that he would notify me if Thomas were apprehended. When I again interviewed his girlfriend, she told me he was living in a motel in the city and had a job there. Accompanied by the investigator on the Kisatchie National Forest, John E. Boren III, I located the motel, and started watching it. During the evening a man—not the suspect—came to the room to pick up Thomas' clothes. At 11:30 p.m., we received a phone call from Thomas, who said he would be in the Ranger's office the next morning. Again he did not appear.

On April 27, Thomas was finally interviewed. He had been apprehended in Minnesota on the bad check charge, and returned to the county jail.

He told the story substantially as it had been deduced, and added details about the shooting. He said he was carrying his pistol in a cocked position and accidentally shot himself in the left leg. After being hit, he became frightened and returned to his truck and got his rifle. He then fired three shots from his pistol at the stock of the rifle, and the remaining shots into the air. He then got back into his truck, returned to his girl's house, and told her about running into the man.

In confessing, he said that he did not know why he had set the fires, that he did not know whether they were on private land or on National Forest land, and that he really didn't care. He told me he was sorry he had set the fires, and that after serving his time on the check charge, he would reimburse the Forest Service in any way possible.

This investigation is an excellent example of what can be accomplished when Forest Service personnel carefully investigate a fire, and receive all possible cooperation from county, State, and Federal law enforcement agencies.

A NEW TOOL FOR SLASH DISPOSAL

ROBERT L. ASHER, *Fire Control Technician*
Winema National Forest

The disposal of logging slash in the pine and transition types has long presented a problem. Patch clearcutting, where the slash can be treated by broadcast burning, is seldom practiced. Selective cutting or various degrees of shelterwood harvesting are much more common. The cost of disposing of the logging debris in these areas is high, and the possibility of the residual stand being extensively damaged is great.

EQUIPMENT TESTS

To reduce costs and to minimize damage to valuable reproduction, personnel of the Wimena National Forest, Oreg., experimented with machine piling. Various tractor sizes, from a John Deere 440 to a D-8, were used. Straight blades and standard brush blades were tested. Success varied according to the combinations of equipment used.

The larger tractors effectively piled the slash, but they were expensive to operate and often damaged the residual stand extensively.

Smaller tractors did not damage the residual stand as much, but they could not move some of the material efficiently.

Use of straight blades resulted in excessive stand damage and soil disturbance. Even the best operator could not see well enough to avoid damage. Also, without the rake effect, either excessive material is left on the ground or much soil is carried into the piles. Therefore, burning was difficult.

Much better results were obtained with the standard brush blade. Because of the rake advantage and better visibility, much cleaner piles were built. Damage to residual stands also was reduced. However, the tractor had to be positioned behind the slash to be piled, or the slash had to be sideswiped away from residual trees so it could be moved into the piles. This operation often created as much slash from destroyed reproduction as the amount treated.

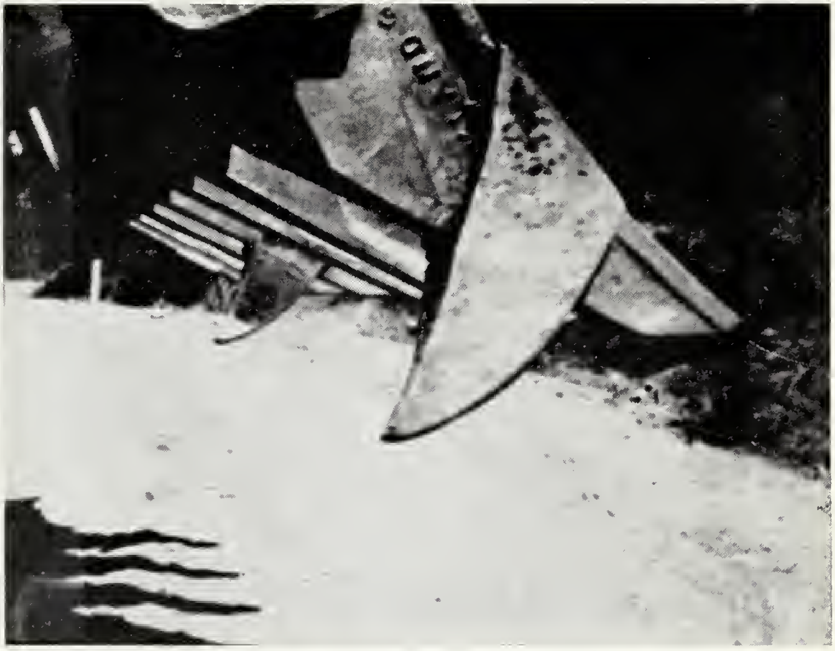


Figure 1.—View of reverse teeth mounted on standard brush blade.

USE OF REVERSE TEETH

To reduce damage to the residual stand, the old principle of reverse teeth on a brush blade was employed. There are several blades which will do the job, but they are quite expensive. They work on the principle of a set of teeth which can be reversed when the blade is to be used to pull material. After the conversion is completed, they make an effective tool. These blades were developed for rock work on road construction, but they are adaptable for slash disposal. Their main disadvantages are their excessive cost and the difficulty and expense of changing the position of the teeth. Also, with the teeth reversed, the blade is not as effective in pushing material.

To overcome these drawbacks, the standard brush blade was modified by welding three solid reverse teeth on the outside and middle teeth (figs. 1, 2). The teeth are small and utilize the back of the brush blade as part of the whole device. The cost of modifying the blade, including buying the stock, cutting the teeth and braces, and welding them in place, was about $75.

ADVANTAGES OF NEW BLADE

This device has several advantages over other brush blades and reverse tooth systems. In addition to lowering the cost of the initial investment, residual stand damage can be substantially reduced because the slash can be pulled away from standing trees instead of being pushed. Second,

Continued on page 12

Slash Disposal—*Continued from page 11*

one piece of equipment can be adapted to several jobs. Finally, the size of the brush crew working with the tractor can be reduced considerably. With the conventional brush blade, six men and four chain saws were needed. They had to hand treat almost 25 percent more slash. With the new blade, the slash could be treated by two men with chain saws and the tractor operator.

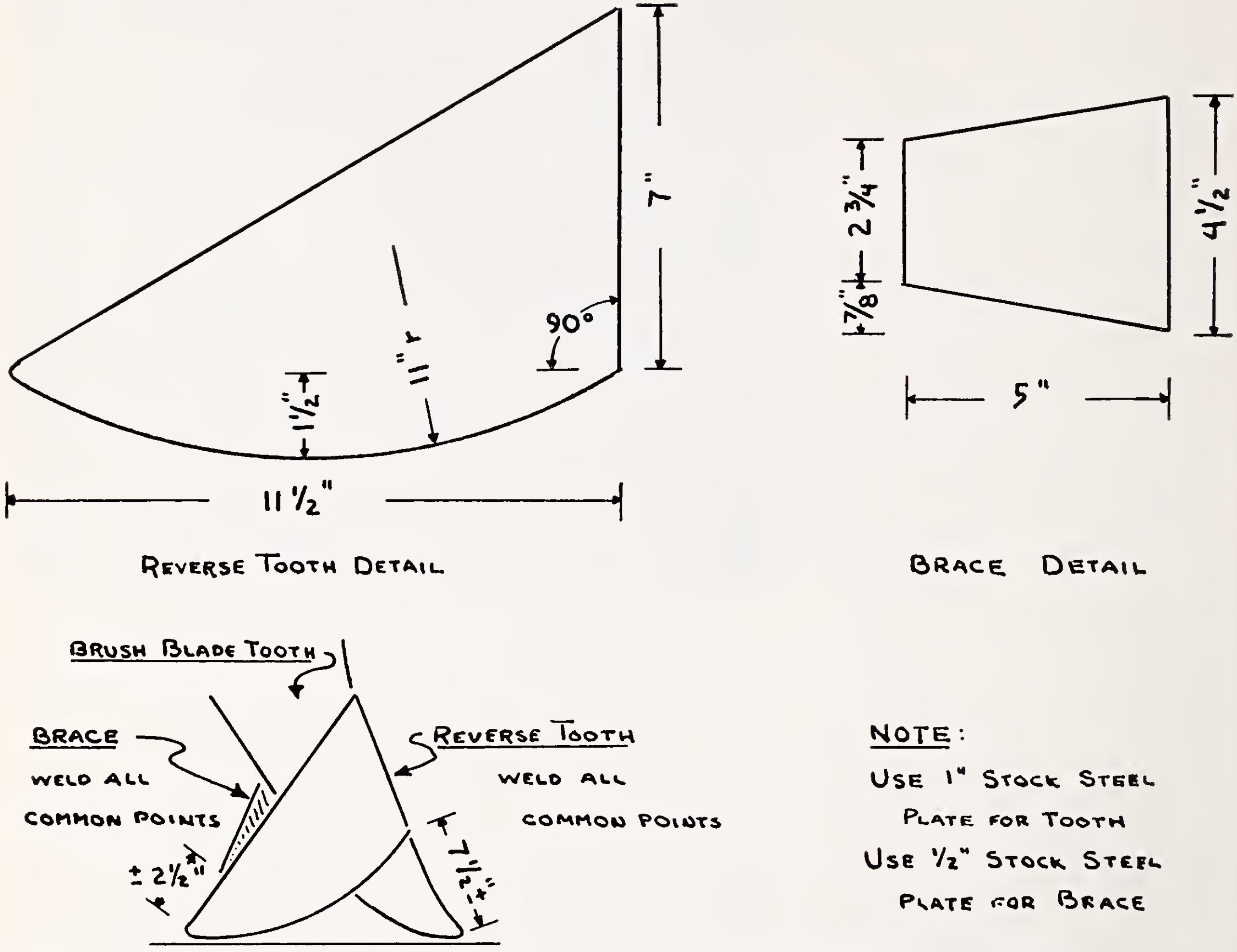


Figure 2.—Fabrication details of reverse tooth and brace are shown. The brace is welded to the reverse tooth and the opposite side of the brush blade tooth.

SPARK ARRESTING MUFFLERS FOR POWERSAWS

Washington Office Division of Fire Control

Forest Service timber sale contracts and other permits usually contain provisions which require spark arresters on internal combustion engines during the fire season. Effective mufflers and arresters for heavy equipment have been available for many years, and in 1959 a standard[1] was established for them to qualify under the contract provisions.

However, this standard does not apply to arresters mounted on engines used in multiposition applications (for example, chain saws). Without definite guidelines to rate such arresters, requirements for chain saws have varied by regions. Usually the standard factory mesh- or baffle-type mufflers in good condition have been accepted for situations other than extreme fire danger.

In 1964, the San Dimas Equipment Development Center conducted special tests to establish suitable requirements for powersaw spark arresters. These tests measured the temperatures of the arrester shell and the exhaust gas, the carbon arresting effectiveness, and the back pressure that developed. Results have been shared with the manufacturers and with the Power Saw Manufacturers' Association Committee on spark arresters.

---

[1] Forest Service Interim Standard No. 1 for Spark Arresters for Internal Combustion Engines, Apr. 7, 1959. (Superseded in Jan. 1965 by Forest Service Standard for Spark Arresters for Internal Combustion Engines, Standard 5100-1)

The Center determined that a screen-type arrester-muffler will meet the requirements for powersaw engines if screen openings do not exceed 0.023 inch. At least 80 percent carbon arresting effectiveness is obtainable. Screen clogging is usually due to lead precipitates from the gasoline, rather than carbon. As with all arresters, careful inspection and maintenance are necessary for satisfactory performance.

While an official standard has not yet been established, the San Dimas Center has developed the following guidelines for powersaw muffler-arresters:

1. The arrester should have a woven screen with a maximum opening of 0.023 inch.
2. The screen should be constructed of heat- and corrosion-resistant wire at least 0.025 inch in diameter. Stainless steel or a chromium alphatized screen is recommended.
3. The total screen opening area (effective exhaust area) should be at least 125 percent of the engine exhaust port area.
4. Construction of the unit should permit easy removal and replacement of the screen for field inspection and cleaning.
5. The arrester should be capable of operating for a minimum of 8 hours before cleaning is needed.
6. The screen should be usable for 50 hours.
7. The screen should be inspected at least after every 25 hours of use, and should be replaced as soon as corrosion and a resultant increase or decrease (clogging) in opening size are noted.
8. Replacement screens should be carried by saw crews.

A FIRE TOOL SUPPLY TRAILER

Milo R. Drilling, *Forestry Technician*
Huron-Manistee National Forest

A fire tool supply trailer developed on the White Cloud District provides a fire cache that can be moved quickly and easily to a going fire (fig. 1). During high fire danger the trailer is dispatched to each fire with the initial attack force, making tools and equipment readily available for use by reinforcements or volunteers reporting at the fire scene.

The trailer can hold tools and equipment for as many as 60 men. It also has a small portable pump, hose, and a 100-gallon water supply (fig. 2). The compartments are of varying size, permitting the transportation of equipment needed for any local conditions.

The unit has a gross weight of 2,100 pounds and can be pulled by a half-ton pickup. It has a "Prior Level Ride" axle, which permits good stability even on rough roads.

The unit, which has proven useful on 20 fires, also serves as a fire headquarters, a communications center, a timekeeper's station, and a first aid station.

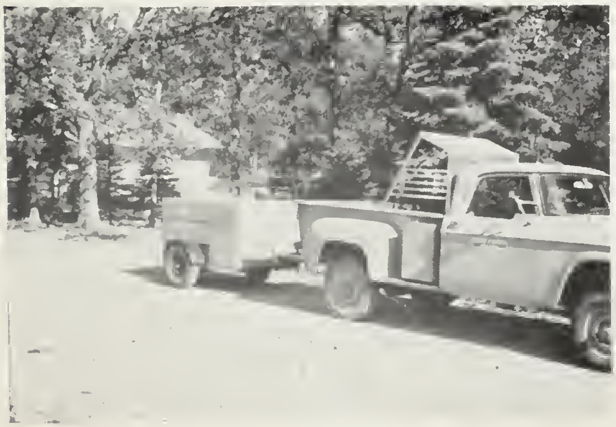


Figure 1.—The fire tool supply trailer is shown.

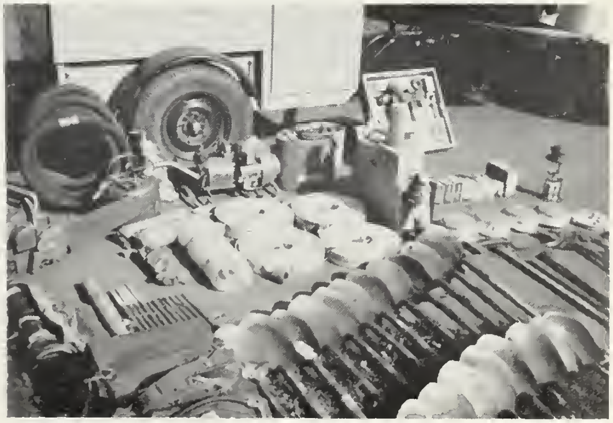


Figure 2.—These tools and equipment are transported by the trailer.

Fire-Weather Stations—*Continued from page 3*

was constructed from 3- to 5-foot segments of hollow aluminum tubing. The stakes for guy wire supports for the tower were driven into the frost with sledge hammers.

The observer, Winthrop Silver, closely watched the unpacking of the instruments and their installation in the shelter. Each instrument and its operation was explained, and indoctrination in taking observations was given (fig. 1). He was shown cloud charts and how to identify various cloud types, particularly the cumulus varieties. He was also shown how to encode the sky condition, dry and wet bulb temperatures, wind direction and speed, rainfall amounts, maximum and minimum temperatures, and thunderstorm activity. Silver was shown how to operate the radio, which we installed in one corner of his log cabin, and how to transmit this information. All fire-weather observers in Alaska report weather data twice daily. These observations are sent by radio to collection centers at McGrath, Fairbanks, and Anchorage at 8 a.m. and at 2 p.m. Alaska Standard Time.

Our airplane finally left the shore at Stevens Village and pulled out onto the wide, roily Yukon River at 6 p.m., and we then flew to the airport at Fort Yukon further to the northeast.

The recorded cost of the initial establishment of the Stevens Village Fire Weather Station was $1,947. This figure does not include time spent in planning or successive costs for operation and maintenance.

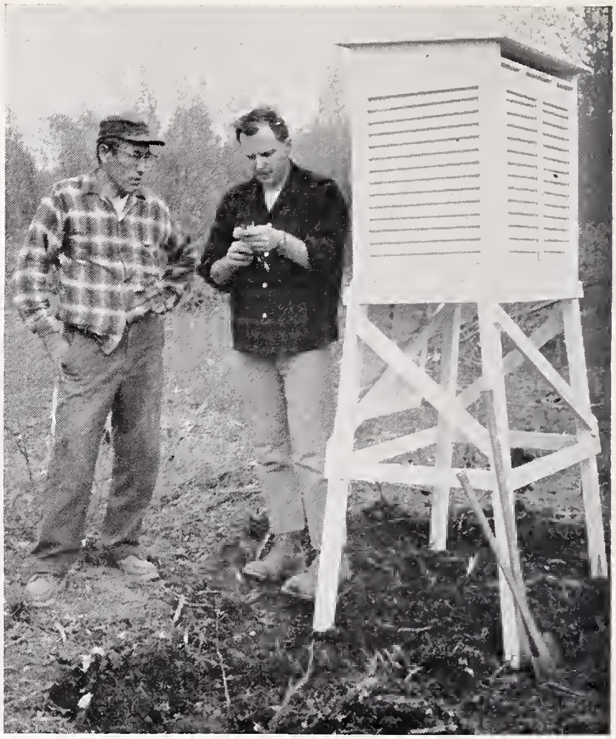


Figure 1.—Winthrop Silver receives instructions on the operation of the newly installed Stevens Village fire weather station, just south of the Arctic Circle in Alaska.

THE FOREST LOG

Oregon Department of Forestry

Forest fires last year destroyed more value in Oregon than at any time since the first Tillamook fire of 1933.

Forest property damage approached $4,050,000 during the 1966 fire season on lands under protection of the State Forestry Department and cooperating Forest Protective Associations. Some 1,301 forest fires burned over 52,671 acres. Although the number was only 20 more than the previous year, the burned area was up 38,625 acres.

The Oxbow fire which exploded on August 20 accounted for 42,875 acres of the burned area this past year and caused in excess of $3,000,000 damage. Control costs on this fire ran to over $900,000. The second most disastrous conflagration was the Ivers Peak fire which occurred on August 9 and covered 1,636 acres before it was controlled at a cost of $443,204. Damage was estimated at $298,225.

Fire Prevention "Tool"—*Continued from page 6*

Wide publicity has been given to the helicopter project. News media personnel throughout Missouri were invited to see the operation. Demonstrations of the aircraft and its capabilities were made at schools and at smaller communities within the study area. Selling fire prevention was the main goal.

RESULTS

The helicopter prevention project is proving effective, not only in the many prevention contacts within the study area but in the investigation of incendiary fires. It has discouraged persons who might set fires because they realize how easily and quickly the crew can arrive (fig. 2). Forest officers directly connected with this project feel that the response of the school children and citizens who have been contacted is good.

One apparent result has been that the incendiary fires are now generally set at night. To counter this effect, the Forest personnel have increased their fixed-wing, multiengine night aerial detection flights, and ground patrols have set up stakeouts during high fire danger. Incendiarists are finding it more difficult to set fires within the study area.

During the 1966 spring fire season, it was difficult to determine the success of the program due to many variables in weather, risk, etc. However, the cost of the project was definitely offset by the reduction in ground forces needed for smoke chasing, fire suppression, investigation, and prevention contacts.

In the fall season, when den tree fires are the main cause of wildfire in the study area, an effort was made to contact all hunters, either at their cars or in their camps. If no one was present, a prevention message was left. Sometimes a hunter or camp would be contacted through the public address system on the helicopter or by dropping a message. During the latter half of the deer season, only one "accidental" fire occurred. During the squirrel season, only one den tree fire occurred in the area; formerly there was a high concentration of den tree fires.

During the 1967 spring fire season, the helicopter continued to prove its value as a prevention tool. Through April 15 the Potosi Ranger District checked 101 landowner-controlled fires which did not develop into statistical fires. The helicopter checked 80 of these. However, eight additional fires escaped control by the owners and required suppression. The average size of these fires was 1.75 acres; prior to the helicopter project, debris fires averaged 6.5 acres.

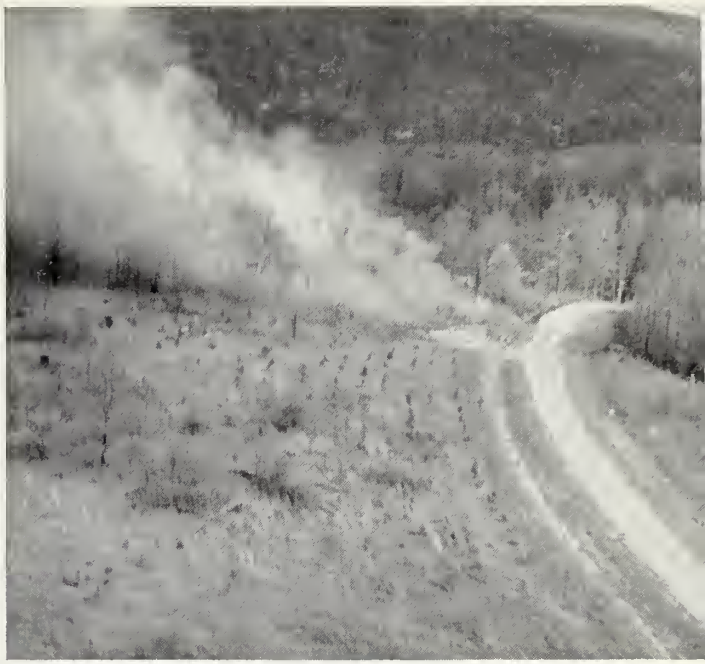


Figure 2.—Fast initial attack by the helicopter crew held this incendiary fire to less than one-fourth of an acre. Their early arrival probably prevented other sets.

CONCLUSIONS

The following improvements in the Forest fire control program have been noted in the study area:

1. No severe incendiary fires.
2. A drastic reduction of hunter and den tree fires.
3. A reduction in debris fires which escaped owners' control.
4. Stimulation of all phases of fire control.
5. A reduction in fire costs, and strengthening of the suppression organization.
6. Good public reaction supporting the stepped-up program and this new "tool."

In summary, the helicopter is proving an effective tool in both fire prevention and suppression in Missouri. But the helicopter alone cannot substitute for all prevention and investigation activities. However, in combination with supporting ground crews, night aerial detection, periodic round-the-clock surveillance, and good public relations, it offers an opportunity to reduce indiscriminate burning in the Ozarks.

U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C. 20250

OFFICIAL BUSINESS

U. S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

ELECTRONIC DISPLAY FOR FIRE NEWS

Merle F. Pugh, *Writer-Editor*
Pacific Northwest Region

Because major forest fires are of interest to almost everyone, Forest Service fire dispatchers are very frequently asked for information during a "going fire" situation. Coworkers and the public want to know what's going on.

Last summer an electric "bulletin board" was installed (fig. 1) in the lobby of Portland's Multnomah Building, where Region 6's headquarters are located. The board proved popular and valuable.

The visual display system was used throughout the fire season to show fire danger by areas and the location and size of going fires. A two-circuit panel in back of a cork facing illuminates the lights (Glo-pins) and tubes (Glo-tubes) stuck into it. A flashing unit permits certain pins to flash on and off (when fires are out of control). Lighted tubes indicate the names of fires burning and their acreages. When a fire is controlled, a "controlled" tag is placed on the tube.

The Region also uses the electronic display to provide information on other National Forest activities. For example, during the winter ski areas are shown. Areas open daily have one color of lights; those which operate only on weekends have another color.

Several electronic display boards are sold; they cost $200 to $2,000. The two-circuit unit purchased by Region 6 costs $360; in addition, a power-pack costs $146; a flashing unit, $82.10; and Glo-pins, $1.75 each. The total cost was approximately $600.

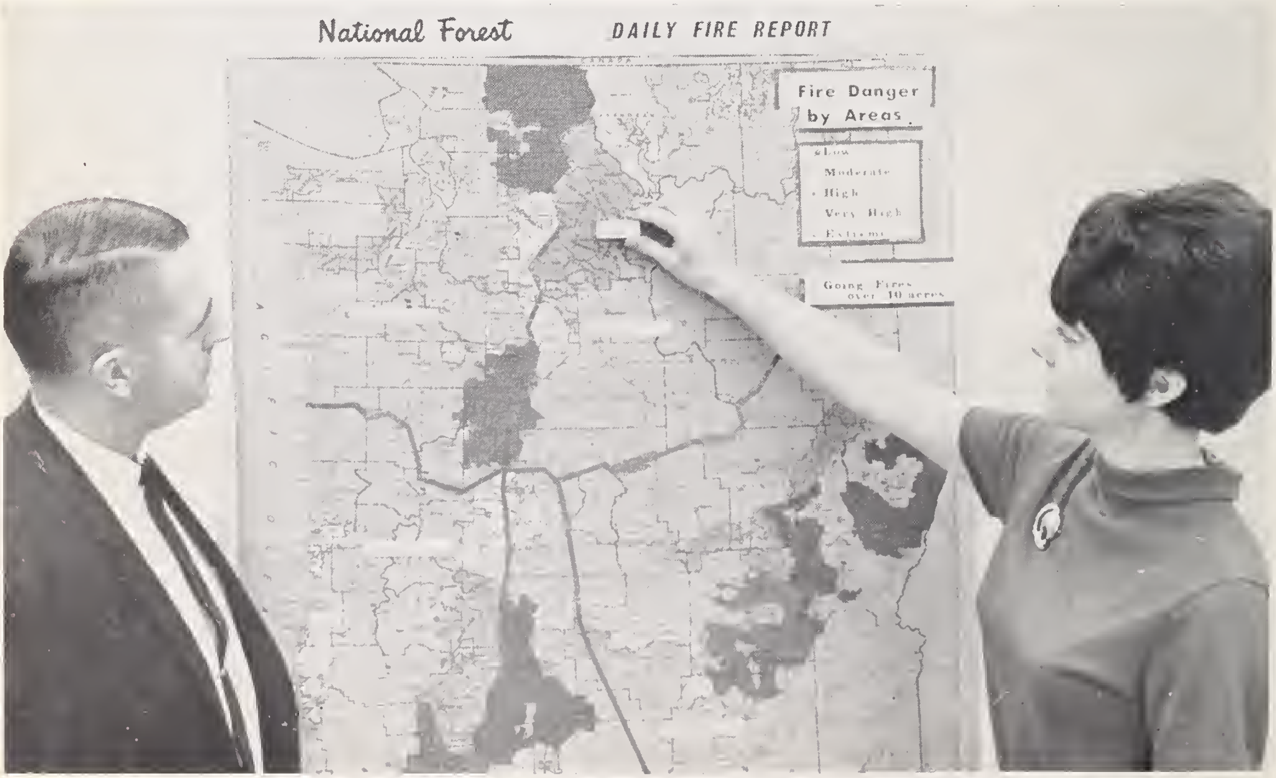


Figure 1.—Region 6 Fire Dispatcher Clarence Edgington and Assistant Dispatcher Yvonne McNeil examine electric display board showing fire danger and going fires.

766Fi
opy 2

FIRE CONTROL NOTES

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JAN 24 1968
CURRENT SERIAL RECORDS

U.S. DEPARTMENT OF AGRICULTURE / FOREST SERVICE / OCTOBER 1967 / VOL. 28, NO. 4

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Page

3 Preparing a Total Prevention Program
MERLE S. LOWDEN

7 A New Mobile Fire Laboratory
S. S. SACKETT and J. H. DECOSTE

9 Cooperators Obtain Extensive Use of Region 6 Fire Simulator
HOWARD E. GRAHAM

10 Incendiary Projectile Launcher Tested for Remote Slash Ignition
JOHN D. DELL and FRANKLIN R. WARD

11 Sprinkler System Protects Fireline Perimeter in Slash Burning
WILLIAM J. ORR and JOHN D. DELL

12 Polaroid Litter May Be Useful Evidence
CLEO J. ANDERSON

13 Fire Retardant Viscosity Measured by Modified Marsh Funnel
CHARLES W. GEORGE and CHARLES E. HARDY

16 Helitanker Prevention Sign Proves Valuable
E. F. McNAMARA

COVER.—A general view of a mobile fire laboratory is shown. See story on page 7.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington. D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

PREPARING A TOTAL PREVENTION PROGRAM

Merle S. Lowden

Director, Division of Fire Control[1]

Fire prevention is an essential part of any comprehensive fire control program. Its need and value are generally accepted by firemen. However, prevention work is becoming more varied and complicated. Many approaches must be considered in planning and executing a total prevention program. To obtain optimum effectiveness, all known and applicable approaches must be used. Some approaches that do not always receive enough attention are discussed in this article.

When the public thinks of fire prevention, it usually visualizes posters, TV appeals, and other information items of the Smokey Bear type. Use of these media is an important part of any comprehensive fire prevention effort, and it is the best method of informing the general public and certain groups such as school children. However, many other approaches to fire prevention are needed in a well-designed program.

In this article other prevention work has been classified into several general fields: Risk engineering, hazard engineering, exposure controls, industrial user controls, and law enforcement. Each of these fields is applicable in various degrees—depending on the location and the prevention problem. It is important to first obtain an optimum analysis of fire causes and then to carefully plan actions to meet needs. It is desirable to try to improve definitions, increase our investigations, and obtain better information on who is responsible and what is involved in man-caused fires. Fire prevention research can be particularly helpful in providing administrators with guides for obtaining better records of fire-starting causes. This effort is now receiving particular attention in a cooperative study project in the South. A fire statistical center is planned. Fire records from all fire control agencies in the Southern States are to be gathered and analyzed.

RISK ENGINEERING

Risk engineering includes all ways of eliminating sparks that start forest fires. Basic research is needed on the sizes and types of carbon that cause fires, how they are emitted, what can be done to eliminate them, and similar problems.

The change to diesel engines did not stop engine fires or fires from diesel tractors. An "offensive" diesel tractor under a heavy load emits sparks from an unprotected or poorly protected exhaust stack. Also, all diesel oils, as well as other fuels, are not equally hazardous. Additives can be placed in fuels to decrease the likelihood of carbon particles starting fires. However, economic considerations further complicate the situation. Cheaper fuels generally cause more fires, and engine designs which reduce the problem often cost more.

Much can be done to prevent "engine" fires. Effective spark arresters will prevent emission of fuel sparks that cause fires. The Forest Service has established a method of testing and certifying arresters that meet a certain standard. A new Identification Guide lists tested arresters. New and better arresters have recently been developed for powersaws and similar small engines. While much more must be known about the sparks from engines, aids and methods for working on the problem are available. Equipment should be inspected regularly by competent specialists to be certain required devices are functioning.

New devices for reducing offensive gases that increase air pollution may be a source of future fire problems. These are being studied at the San Dimas Equipment Development Center (Calif.). New cars with these devices may prove a source of serious trouble. These devices, now required in some areas, are fairly certain to receive wider use. When smog control equipment is attached to engine exhaust systems, the temperature usually rises. Some afterburner-type units still undergoing research may produce exhaust gas temperatures high enough to ignite forest fuels. Development of special protective devices such as guards or exhaust deflectors may be needed. Fortunately, automotive engineers are also trying to solve the smog problem by "cleaning up" motor designs. The trend is to design out smog-producing characteristics and thereby obtain better combustion for the car of the future. This approach is much more practical than adding apparatus to the present exhaust systems; such additions may create corrosion which destroys metal parts in about 10,000 miles, or causes high temperature. Also, it seems there will always be the motorist who drives through dry grass. Such grass may have an ignition temperature dangerously close to the heat of his dragging exhaust system. His tail pipe may be turned down, his muffler defective, and his engine missing.

---

[1] This article is adapted from a speech presented at the Society of American Foresters Annual Meeting, Seattle, Wash., Sept. 14, 1966.

There are also fires from railroad brake shoes and sparks from pulleys and cables. New electric brakes prevent brake shoe fires, but sparks from cables are particularly troublesome. New types of materials must be sought. Alert vigilance can help at points where cables contact wooden fuels. Increases in cable logging and even the new balloon systems that use cables may be a problem. The need to be alert to new risks is constant.

Community dumps have been a fire risk source for many years. In some localities legislation concerning their location and other safeguards has been helpful. Many fire control units have made special efforts to clean up or "fireproof" dumps. Such efforts have usually eliminated or greatly reduced dump fires. A new, mobile incinerator has had favorable use for campground refuse, but dumps for local refuse are sure to be used for many years. These dumps must not continue to be a cause of wildfires. There is much that can be done to improve the "fire proofability" of most dumps.

HAZARD ENGINEERING

Obviously the objective of prevention is to prevent sources of ignition from contacting burnable material. Hazard engineering can eliminate natural vegetation and other materials that burn. Vegetation can be removed where sparks are most likely to fall—along railroads, on roadsides, in recreation areas, near powerlines, and in similar places. Some phenomenal results have been obtained from close cleanups along certain sections of railroad tracks and highways (fig. 1). Fire crews of the San Bernardino National Forest, Calif., have done much such work along forest roads and highways. They cleared road edges for 10 feet on many miles of highways and roads and reduced roadside fires from 52 to 11 percent of all fires on the Forest.

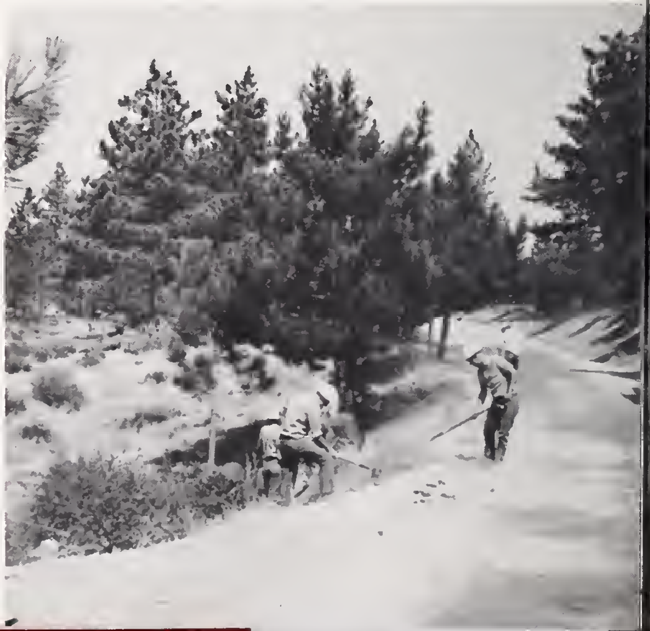
One stretch of railroad had a history of high, but fluctuating, fire incidence. The number of fires was almost directly correlated with good or poor right-of-way cleanup. On a short section of right-of-way, railroad fires averaged 7 to 9 per year. After a cleanup, there was none.

Firemen have long searched for a retardant to spray over high-risk fuels to keep them from igniting. Tests in California and elsewhere have revealed some retardants that are effective but not durable—the first rain washed them away. An effective and economical retardant will be found, but more effort is needed.

The chip problem along certain railroads has been particularly vexing in recent years. Chips blowing off heaped railroad gondolas pile up on rights-of-way, particularly where wind currents are strong. These chips provide an ideal fuelbed for sparks to ignite. They also are a safety hazard when they block railroad switches and tunnel drains. Concern about this safety hazard, or the persistence of protection agencies, or possibly a combination of both, has resulted in some improvement. Intensive cleanup of chips has been done in a few places. An embargo on high-piled uncovered cars in the Pacific Northwest has produced definite results, and chips are no longer "flying" at will. Cutting the height of chips on cars or putting on either permanent or temporary covers can pretty well cure this problem.

At the national level, the American Association of Railroads and the Railroad Section of the National Fire Protection Association have promised to help with the railroad fire problems. Several States, including Michigan, Missouri, and Califor-

Figure 1.—Cleanup of hazardous material along roadsides greatly reduces the chances of fires starting. Those that do occur spread slowly and can be quickly controlled.

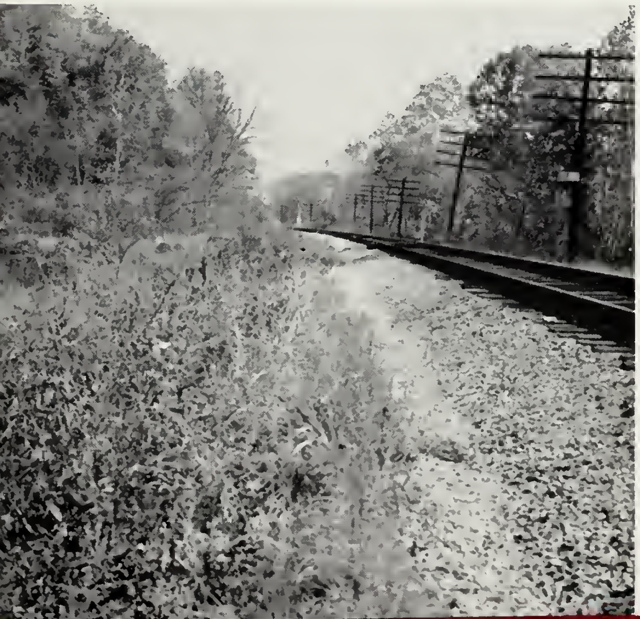


nia, have been working hard with railroads on hazard and risk problems. It is particularly important that local fire managers work with railroad people both to make them aware of problems and to seek joint solutions (fig. 2).

Highway fire prevention cleanup can and does enhance roadside beauty. Foresters are rightly concerned with soil erosion. But to prevent disastrous fires, some small soil losses may have to be accepted temporarily. For example, vegetation may have to be removed along roads until a cover is found which does not ignite. We need to be working with highway commissions and road engineers to design roadsides that are less hazardous as sources of fires. Snags or trees frequently fall across powerlines and produce fires. Removal of dead and risk trees can prevent most of these fires. Research is needed on roadside fire hazards and their alleviation.

The elimination of fuels where fire starts are likely is being done around forest homes and other buildings surrounded by flammable fuels. California's "Fire Safe", a formal program, has this aim. State officials hope to extend law enforcement so the program will be successful. They are convinced it will eliminate many fires, particularly those that start in the most hazardous places and often cause large property losses. We now accept as standard practice cleanup in recreation areas (especially around fireplaces, stoves, and tables). Dust likelihood may prevent a complete cleanup in such places, but we can at least lessen the problem. The search for new fireproof ground covers needs to be continued. We need "fireproof" overlooks, vistas, waysides, and similar places where people congregate.

Figure 2.—Concentrations of light fuels along railroad rights-of-way present a severe hazard and substantially increase the chances for railroad fires to occur.



Some people broadly define prevention and include the action needed to hold fires to small size. This may seem like suppression rather than prevention. It is valuable to build firebreaks and wider fuelbreaks to stop fires or help hold them at critical locations. This is the chief purpose for the cleared lanes on the ridgetops over much of southern California, and such areas are being cleared in other parts of the country. For years "light" burning has been advocated to remove hazards, and it can be effective in prevention. Such burning should be carefully prescribed and competently done. There is no question that fire, if properly used, can prevent many fires and hold others to small acreages. While, this in reality may not be fully pertinent to this general subject, it is in effect, hazard engineering.

Regulation of burning, on government or private land, is a particularly important prevention job. Debris burning is one of the large causes of fires, and these fires often occur at critical times and in especially hazardous places. Both hazard and risk engineering are involved. When a better way is found to dispose of limbs and other slash debris or to make them less hazardous, more fires will be prevented. On some National Forests operators bury debris on road construction projects. This eliminates the hazard and also the risks of escape fires when burning is done. Experiments have been conducted with various chemicals and decomposition agents including fungi to dispose of fuel debris, but I know of no noteworthy results. Current concern for clean air has raised many questions as to the effect of hazard reduction by burning on air pollution. We have some facts, and research is being conducted to find more. It's a big job to explain our work to "Clean Air" administrators so excessive restrictions are not placed on burning. Formulation of mutually satisfactory regulations and methods will continue to require orientation and understanding by all concerned.

EXPOSURE CONTROLS

There are a wide variety of actions under exposure regulation. Limiting the exposure of the forest to fire risks may restrict the activities of individuals and often is unpopular. In the Forest Service, our general objective is to permit maximum use of the National Forests. In some locations it is necessary to restrict the use of fire under extreme conditions of fuel, weather, or exposure. Sometimes an area may be closed to all use. However, at other times people may merely be required to smoke only in certain areas, obtain a campfire permit, or carry fire tools.

Even changing the hunting seasons to keep people out of the woods at certain times is a form of exposure regulation. Like other regulations, it is only used when other means are not adequate. Regulations are usually resisted, but people informed of the reasons for limitations are remarkably willing to comply with them. Mass media can be particularly helpful by advising people of severe fire danger and the reasons for restricting their actions. All regulations should be lifted as soon as possible.

Signs and posters are used as part of exposure regulations. These are used to motivate people to action or inaction when they are exposed to forest fuels. We are just beginning to learn, through research and tests, about effectiveness of various signs. It is certain that people must see, read, and understand a sign before they will act upon it. It should provide a reason, a stimulation, or a reward for doing the right thing. All of these things need consideration in sign planning as a part of your total prevention program.

INDUSTRIAL USER CONTROLS

Industrial users working in forests are in a somewhat different class, and controls on their actions are usually applied differently. The work they do may be under some type of permit, contract, or special regulation. This permits an advance determination of restrictions to action, and sometimes these can be put in writing. With recent improvements in fire danger rating, these exposure requirements can be more closely related to action fire needs. For instance, we can specify by humidity readings or danger ratings when a logging operator will be permitted to log. Fires start much more readily when relative humidities are below 25 percent. Thus, some special regulation of the exposure is needed. Other restrictions such as demanding watchmen during certain seasons, requiring mufflers or spark arresters, and designating when and where fires may be built all contribute to prevention.

LAW ENFORCEMENT

Another general prevention category is law enforcement and the accompanying trespass or collection action. This should not be slighted in a prevention program. All law enforcement should have as its chief goal the prevention of fires. This is true whether it is applied to enforcement of prefire efforts such as rules and restrictions or in the investigation and apprehension of fire starters. It is important to apply the law equally to all people, but it is also important to keep the prevention objective foremost in mind. We often do not have choices, but where we do, we should stop and appraise. Are we doing this or taking this action in a manner that will obtain maximum prevention, or are we being vindicative, arbitrary, or too authoritative?

It is established Forest Service policy and practice to try to collect both costs of suppression and resource losses from those responsible for starting fires. Many ramifications of responsibility, negligence, and similar items are involved. An aggressive program of trying to collect from fire starters or those responsible has had a marked effect in preventing fires in many places. Since this is a specialized activity, we have found trained, full-time law enforcement officers particularly helpful in areas where there is much of this business; they also provide assistance in areas where personnel don't have much such business.

Closely related to law enforcement are deterrent activities that keep people from violating laws or regulations. These have much the same effect as the policeman on the beat. They range from a "red" fire pickup going up a road to a helicopter overhead with a prevention banner. Certainly, people are more careful if they are being watched. Helicopters and airplane patrols have been effective in reducing incendiary fires. Night patrols with aircraft have worked well in reducing incendiary fires in Missouri. Frequent patrols and "fire-chasing" helicopters in incendiary areas have been helpful.

There is another prevention activity I should mention which cannot be placed within any of the categories I have listed. But it is directly related to all of these categories. This is the human engineering or a person-to-person relationship between a fire officer and a possible fire starter. There are many approaches and methods in human engineering. They range from contact with a known incendiarist to a casual conversation with a forest visitor. Men who spend all or most of their time on this work are especially desired, but we don't have the funds to hire nearly enough of these people. Yet we recognize their great value and hope to hire more.

When I ask field men what they need most to improve their prevention work, they often tell me they need more prevention patrolmen or specialists. This is an age of specialization, and these men can develop many new and improved approaches and techniques. Through training these techniques can be transmitted or improved. In a total prevention

Continued on Page 15

A NEW MOBILE FIRE LABORATORY

S. S. Sackett and J. H. DeCoste, *Research Foresters*
Southern Forest Fire Laboratory
Southeastern Forest Experiment Station
Macon, Ga.

A new mobile fire laboratory is being used at the Southern Forest Fire Laboratory to scientifically document both high-intensity (blowup) wildfires and prescribed fires. The unit also can be used for investigating fuels, collecting meteorological data, and other special purposes. The laboratory has already proven valuable in the documentation of a series of prescribed fires and in the monitoring of a wildfire during the disastrous spring 1966 fire season in South Carolina.

The mobile laboratory is used as a base station and is the control and communications center for all documentation activities. Primary weather observations are taken at the mobile unit. Recording meteorological instruments are used for making a continuous record of onsite weather conditions throughout the burning period. Fuel moisture is also determined at the fire site.

DESCRIPTION OF BASIC UNIT

The basic unit is a 20-foot, tandem-axle house trailer drawn by a ¾-ton truck. The truck has a V-8 engine with an all-wheel drive. An observation deck has been installed on the top of the trailer; the deck also provides a base for radio antennas and an anemometer staff. A compact laboratory in the trailer contains considerable scientific and electronic equipment; much of this equipment is specifically designed for fire research. There are also general facilities such as gas, air, and vacuum outlets, an electric balance, and other laboratory hardware. A constant operating temperature for electronic equipment is maintained during the summer by a 7,000-B.t.u. air conditioner and in the winter by an electric heater. Electric power is supplied by a 5,000-watt, gasoline-powered generator. An auxiliary 2,500-watt unit is transported with the trailer for use in case of primary equipment failure. Both generators produce 120-volt, 60-cycle current.

FIRE WEATHER STUDIES

A basic requirement for documenting wildfires or prescribed fires is observation of onsite meteorological conditions that affect fire behavior. Relative humidity, temperature, windspeed, wind direction, and barometric pressure are recorded continuously during the entire documentation period.

Relative humidity and temperature are recorded by hygrothermographs in portable weather shelters. A microbarograph is used to continuously record station pressures.

A system utilizing a Gill microvane and three-cup anemometer as sensors is used for wind observations. The anemometer has a threshold value of 1.25 m.p.h. A dual-channel galvo recorder permanently records wind direction and windspeed on a 0- to 50-m.p.h. or 0- to 100-m.p.h. scale. The sensors can be placed at any height desired. However, they are generally used at the 20-foot height (or its equivalent) in the open and at the 4-foot height within the stand. An aerovane coupled to a dual-channel recorder provides a reserve wind-recording system. The aerovane, which is not as versatile or sensitive as the basic system, is mounted on a mast above the observation platform.

Portable equipment—sling psychrometers, Dwyer wind meters, aspirated psychrometers, Biram anemometers, and compasses—is carried with the trailer for onsite readings.

Current observations on atmospheric conditions aloft are restricted to single pilot-balloon soundings (pibals) for determining windspeeds and wind directions. Two theodolites, a helium tank, balloons, a plotting board, and pibal accessories are stored in the trailer. Future observations on winds aloft may include double theodolite soundings.

Now under investigation is a cold-rocket system designed to carry a radiosonde aloft for monitoring relative humidity and temperature from ground level to 5,000 feet. Data will be radioed back to a recorder in the trailer. Relative humidity and temperature profiles can then be plotted and used to calculate atmospheric stability. This setup should provide much needed information on the relationship of stability and extreme fire behavior.

FUEL MEASUREMENTS

An electric oven is used to dry fuel samples for weight and moisture content determinations. Because at least 24 hours are required to ovendry pine-litter samples at 85° C., this arrangement is used only during a long stay in the field. A Karl Fischer titrimeter to permit immediate moisture content determinations is being installed. These measurements will be especially beneficial for use in prescribed burning. An Ohaus moisture determination balance is also used in the fuel moisture measuring system.

FIRE TEMPERATURE MEASUREMENTS

In documenting prescribed fires, fire temperatures are related to time. The principal value of the data obtained is its relation to research being done on lethal time-temperature ratios for control of undesirable species. The measuring system is composed of four temperature sensing staffs, four strip-chart recorders, a multipoint, automatic reference-junction compensator, a control jack-panel, a 1,400-foot extension cable, and four 150-foot fireproof extension cables. Each temperature sensing staff has four chromelalumel thermocouples. These thermocouples are permanently mounted at four heights—ground level, 1 foot, 4 feet, and 8 feet.

Fireproof lead assemblies are used within the fire area to connect the temperature sensing staffs to an extension cable that runs back to the trailer.

The reference junction compensator has a constant reference temperature of 150° F. The recorders have an adjustable span between 0 and 50 millivolts. Each recorder measures temperatures at one specific height (fig 1).

At present, only one temperature sensing staff can be connected at one time. The staffs are placed in the fire area so that, as the fire progresses, the main extension cable can be manually shifted to each fireproof lead assembly for each respective staff. However, the system has been designed so that when more extension cables are added, the switching may be done at the control jack-panel rather than manually in the field.

PHOTOGRAPHY

Photography is important in the documentation of fire behavior and fuel conditions. For fire behavior, emphasis is placed on color photography because better contrast is achieved between the smoke column and background.

Different models of 35-mm. cameras are used, but the most effective and versatile type for

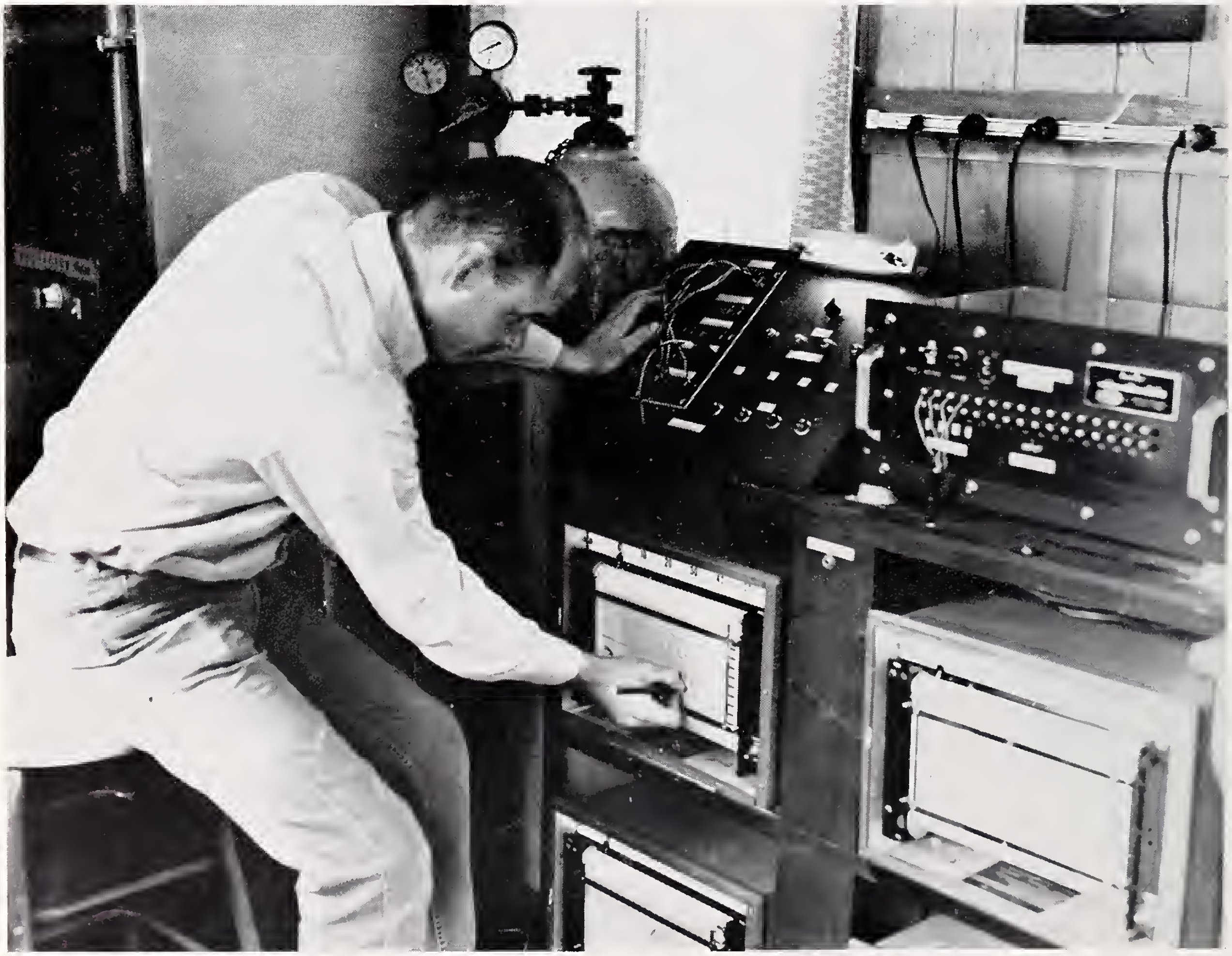


Figure 1.—Data on fire temperature over time will help in determination of lethal ratios for control of undesirable species.

fire photography is one in which the lens f-stop and distance settings can be set while the observer is looking through the viewfinder. Black and white photography is done with a 4 by 5 graphic camera.

A 16-mm. movie camera with an electronic time-lapse mechanism is used to record the shape, angle of tilt, motion, and circulation in the smoke or convection column associated with high-intensity wildfires.

COMMUNICATIONS

When high-intensity wildfires are being documented, radio communications must be maintained with the fire control organization. Mobile transceivers that operate on State fire-control frequencies in the Southeast have been installed in the tow truck and in a sedan. To supplement these mobile radios, crystal receivers, which can also monitor the State fire control frequencies, have been installed in the trailer.

To keep current on the weather situation, a surplus Government BC-348-R receiver is used for monitoring the continuous transcribed weather broadcasts from the Federal Aviation Agency's Flight Service Station. These broadcasts, covering a 250-mile radius from the station, give a brief weather synopsis, a forecast of significant area weather, a winds aloft forecast, local radar reports (RATEP), and selected pilot reports (PIREPS).

Intracommunication between team members and the mobile laboratory is also essential in documenting prescribed fires. Communications are maintained by a network of portable transceivers. One transceiver is permanently mounted in the trailer and serves as a base station.

ACCESSORIES

Incidental, yet desirable, items for the operation of the mobile laboratory include the following:

1. Tote-Gote trail scooter (valuable for moving documentation equipment into the field and fuel samples back to the trailer)
2. Collapsible anemometer mast (20 feet)
3. Exterior-mounted machinist's vice.
4. Mechanic's and carpenter's handtools
5. Hand-operated winch (1,000-lb. capacity)
6. Screw-type trailer stabilizer jacks
7. Pioneer tools
8. Electrical repair kit with soldering gun
9. Trouble lights and exterior floodlights
10. Assorted hand-held battery-operated lights
11. Office and drafting accessories
12. Small library of pertinent literature
13. Field first-aid kit with oxygen equipment and stretcher
14. Complete set of fire handtools with gasoline-powered trench flailer

SUMMARY

Prescribed fires and wildfires are complex, and collecting accurate scientific data, especially on high-intensity wildfires, is very difficult. The mobile fire laboratory provides a method for thoroughly documenting such fires.

There have been few documentations; therefore, the data have not been used much. However, as more prescribed fires are recorded, detailed analyses will be necessary to interpret the data and provide meaningful guidelines for conducting more efficient and effective prescribed fires. Also, as more wildfires are documented, fire behavior and the variables affecting it will be better understood.

COOPERATORS OBTAIN EXTENSIVE USE OF REGION 6 FIRE SIMULATOR

Howard E. Graham, *Forest Service*
Portland, Oreg.

The Region 6 fire simulator was constantly used from late September 1966 through mid-July 1967. It was in Region 6 for 29 weeks and in Regions 1 and 5 for a total of 11 weeks.

In Region 6, 530 men received valuable training. More than two-thirds of these men were from cooperating agencies. Use in Region 6 was as follows:

Agency	Time used (*Weeks*)	Men trained (*No.*)
Oregon State Forestry Department	19	275
Bureau of Land Management	2	36
Washington Department of Natural Resources .	1	24
Washington Forest Protection Assn. . . .	1	20
Forest Service, Region 6	6	175
Total	29	530

It is planned to make the simulator even more accessible to cooperators. The simulator has been used only at the Forest Service Redmond Air Center, Redmond, Oreg.; cooperators will soon be able to assemble and use the simulator at their own facilities. In preparation, Region 6 personnel have trained cooperator personnel as simulator instructors.

INCENDIARY PROJECTILE LAUNCHER TESTED FOR REMOTE SLASH IGNITION

JOHN D. DELL AND FRANKLIN R. WARD[1]

Burning logging slash on steep, clearcut units in the Pacific Northwest is hazardous work. Dislodged rocks or rolling logs often endanger firing crews working downslope. There is a need for a method of slash ignition that can be done remotely from accessible spots outside the logging unit.

In the fall of 1966, a pneumatic incendiary projectile launcher was tested for slash ignition in the Douglas-fir region (fig. 1). The test site was an 85-acre clearcut unit on the Umpqua National Forest, Oreg.

An earlier demonstration of the launcher had indicated that it might prove effective for backfiring or for prescribed burning.[2] Originally designed as an airborne launcher for smoke markers in antisubmarine warfare, the device can fire projectiles filled with any gel-like fuel.

In the Oregon tests, a commercial diesel-gel product was used. The launcher was pallet-mounted. Bottled nitrogen provided pneumatic pressure. The purpose of the test was to determine if the launcher's accuracy, range, fire-starting capabilities, maneuverability, safety, and ease of handling were suitable for effective remote slash ignition.

TESTS AND RESULTS

The projectiles used were military surplus items. They were made of wood; they weighed about 24 ounces, and were 3 inches in diameter and 18 inches long (fig 2). A delayed fuse ignited the projectile's fuel store about 10 seconds after impact.

To test the launcher's effectiveness and accuracy, we designated and marked 10 preselected target areas. The launcher was first set up on a road across a canyon 500 yards from the unit to be burned. The launcher, however, could not project the missiles further than 350 yards, although the manufacturer claimed to have fired projectiles as far as 500 yards in some previous tests. Only three rounds were fired from this spot.

We then moved the equipment across the canyon to a position on a landing above the slash unit. All remaining rounds were fired from that position, down and laterally along the slope. Nearly all firing was done with the launcher in a mortar position, lobbing the projectile toward its target. Of the 18 rounds fired, 10 ignited in the general vicinity desired. The remaining eight projectiles either broke upon impact, failed to ignite, or completely missed the designated target areas. Accuracy—even at the closer ranges—was only fair. Of the 10 rounds which ignited slash, eight were within a

Continued on Page 15

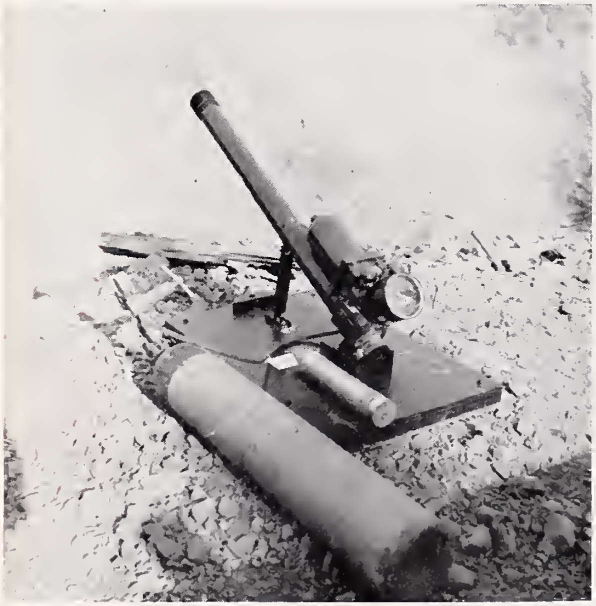


Figure 1.—In the Oregon tests, the incendiary projectile launcher was fired up to 350 yards.

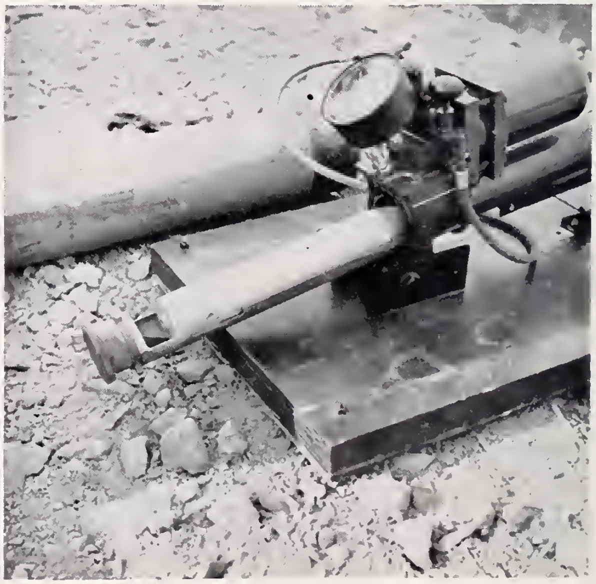


Figure 2.—Exit velocity of projectile is determined by the pressure stored in the pressure chamber, which completely empties after each firing.

---

[1] Respectively, Forestry Research Technician and Research Forester, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] Nailen, R. L. New technologies field-tested at California brush fire. Fire Eng. 119(2) : 49–50. 1966.

SPRINKLER SYSTEM PROTECTS FIRELINE PERIMETER IN SLASH BURNING

WILLIAM J. ORR AND JOHN D. DELL[1]

Broadcast burning of logging slash on Douglas-fir clearcut units nearly always presents some risk. Usually, careful planning reduces most of the risk. Firelines are constructed on unit perimeters, snags are felled, and fire pumps, hoses, tankers, and manpower are positioned for optimum fire control.

A difficult slash burning job may require special control measures. Where water is available, an oscillating sprinkler system shows promise for protecting the fireline perimeter. Such a system can be used to saturate live vegetation and dead fuels at critical points next to firelines. And the water, if properly applied, can reduce or eliminate both spotting and fuel ignition by fire radiation.

A simple, effective, and inexpensive sprinkler system for extra fire protection on slash burns has been developed by fire control personnel of the Sweet Home District, Willamette National Forest, Oreg.[2] District personnel have used the sprinkler system effectively on several difficult prescribed burns. If topography and accessibility are not too adverse, a two- or three-man team can usually set up the system in half a day. Vegetation outside the fireline usually can be adequately saturated in 4 or 5 hours. Sometimes the system is set up the day before a burn and operates overnight.

The use of sprinkler systems for slash burning is not a new concept. Although use has been limited in the Pacific Northwest, several similar sprinkler innovations have been used in recent years on the Gifford Pinchot (Wash.) and Mt. Hood (Oreg.) National Forests.[3] In the Kamloops District, British Columbia, Canada, 30-inch lengths of hard plastic pipe for spray nozzles have been used with some success.[4] Several small holes are drilled into the pipe; each section is bowed into an arc with wire. Regular 1½-inch hose couplings were fastened to pipe ends to permit the attachment of hose line. The system uses a pump or gravity-supplied pressure of 90 to 150 p.s.i.; each sprinkler covers a 50-foot area.

THE SWEET HOME SYSTEM

The Sweet Home sprinkler system consists of regular 50-foot sections of 1½-inch CJRL fire hose that distribute water to a maximum of 20 oscillating Rain Bird sprinklers. The sprinklers can be adjusted to any degree of rotation required. Usually 180° is used so that only the area outside the fireline is wet down. The system can cover up to 1,000 lineal feet of fireline. The number of sprinklers that can be operated effectively depends on the capacity of the pump being used and the elevation that the water must be lifted.

Each sprinkler (fig. 1) is mounted on a 4-foot section of rigid galvanized steel conduit connected to a ½-inch tee. A 12-inch length of conduit, with a short piece of ⅝-inch iron rod driven into one end, is connected to the other end of the tee. The rod serves as a spike for driving the sprinkler mount into the ground.

Water is distributed from the main line to the sprinkler mount through a 5-foot length of ¾-inch plastic garden hose. One end of the garden hose is connected to the ½-inch tee on the sprinkler mount. The other end is connected to a faucet and hose line tee. These outlets are spaced at each couplings along the 1½-inch hose line. The faucets allow adjustment of volume and pressure at each sprinkler head so that the maximum number (20)

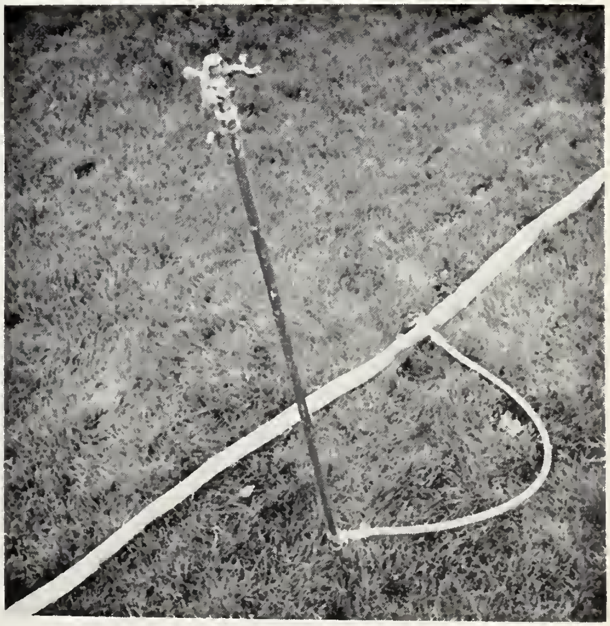


Figure 1.—The main line, sprinkler connection, and sprinkler are shown. The sprinkler is mounted on a 4-foot section of rigid galvanized steel conduit.

---

[1] Respectively, Fire Control Officer, Sweet Home District, Willamette National Forest, Oreg., and Forestry Research Technician, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] The sprinkler system was developed by William Orr, Cliff Dewey, and George Schram, Sweet Home District, Willamette National Forest, Oreg.

[3] Anonymous. Slash burning job eased by sprinklers. Forest Industries 93(13): 75, illus. December 1966.

[4] Anonymous. Slash-burn sprinklers. British Columbia Lumberman, p. 42, August 1965.

can be operated if desired. The adjustments must be made progressively from the lowest to the highest elevation to provide an even distribution over the line.

An Edwards 120 fire pump, capable of 45 g.p.m. at 150 p.s.i., is used with the system. Any pump with an equivalent capacity would be adequate.

Hoses are laid directly on the fireline, with each sprinkler 5 feet outside the line. Mounts are driven into the ground at right angles to the slopes to provide maximum sprinkler coverage. When operating at 180° rotation, the sprinklers provide a 25-foot-wide wet line. At full rotation, the width is doubled. At corners, the sprinklers are set at 270°.

The sprinklers are also useful in mopup operations to wet down smoldering embers in the burn area. The sprinkling begins from the fireline perimeter, and the system gradually is moved inward.

Sprinkler systems often provide the extra margin of safety necessary in difficult areas where steep topography, aspect, fuel concentrations, or poor boundary locations increase the risk of fire escapes. They also increase the feasibility of burning out of the normal season under more severe conditions. Sprinklers are not applicable to all prescribed burning, but they often are useful tools.

EQUIPMENT

In addition to a fire pump and sufficient fire hose, the system requires the following parts and equipment (source of supply shown after description of item): [5]

100 ft. Conduit, rigid galvanized steel, ½ in. (10-ft. sections)—General Services Administration
100 ft. Hose, garden, plastic, ¾ in.—GSA
10 ft. Rod, iron, ⅝-in. diameter (cut in 6-in. lengths) local machine shop
20 Pipe tees, ½ by ½ by ½ in.—GSA
20 Pipe couplings, ½ in.—GSA
20 Pipe nipples, ½ by 3 in.—GSA
20 Hose line tees, aluminum or brass, 1½ in. female by 1½ in. male by ½ in. female—Western Fire Equipment Company
20 Faucets, with hose bib, ½ in.—GSA
20 Sprinklers, Rain Bird, full circle—local distributor
19 Hose couplings, ¾ in. (reusable)—GSA
20 Hose clamps, ¾ in.—GSA

ASSEMBLING THE SYSTEM

1. Cut the 10-ft. lengths of ½-in. conduit in half, and cut 12 in. off each unthreaded end.
2. Drive half the 6-in. pieces of ⅝-in. rod into one end of the 12-in. section of conduit (use a press if available).
3. Cut pipe threads on the opposite end and also on the unthreaded end of the 4-ft. piece of conduit.
4. Remove the male fitting from the 100-ft. length of plastic garden hose and cut into 20 equal lengths. Attach female hose coupling to one end of each piece.
5. Slip the other end of the garden hose on the ½-by 3-in. pipe nipples and apply hose clamps.
6. Sharpen the end of the protruding ⅝-in. iron rod to a blunt point and assemble at bottom end of conduit mount.

COSTS

The cost of the 20-unit (1,000-ft.) sprinkler system is about $350, not including the main line hose and pump. When costs for assembling are added, (about 2 man-days), expenditure would probably total about $400.

---

[5] Many commercial sprinklers are available. The Sweet Home system uses a Rain Bird model No. 25 PJ, which has an output of about 5 g.p.m. at 50 p.s.i.

POLAROID LITTER MAY BE USEFUL EVIDENCE

Cleo J. Anderson, *Forester*

Prescott National Forest

A search for evidence after suppression of a man-caused fire on the Carson National Forest uncovered much common picnic litter and a half-dozen throwaway negative tear sheets from a Polaroid camera. The tear sheets gave us some hope of identifying the offenders.

However, our hopes were diminished when we contacted a photographer to see if an image could be produced from the discarded tear sheets. He called the Polaroid factory and was told it could not be done.

The local FBI agent was then contacted. While he could not assure us, he was very cooperative and said he would see what was possible. The FBI was able to produce a picture from the blank-looking piece of black paper. This knowledge will be useful to other investigators who find discarded Polaroid tear sheets at the scene of a trespass.

FIRE RETARDANT VISCOSITY MEASURED BY MODIFIED MARSH FUNNEL

Charles W. George and Charles E. Hardy, *Reseach Foresters*

Northern Forest Fire Laboratory
Missoula, Mont.[1]

Use of chemical retardants in forest fire suppression is now a firmly established procedure. To obtain the most effective application, the optimum viscosity for each retardant is needed. In turn, optimum viscosity of each fire retardant depends on the project for which it will be used.

Retardants applied from ground equipment must be viscous enough to build up a thick layer on the fuel, but must remain easy to pump. Those applied from air tankers must be more viscous in order to cling together during the drop and to reach and adhere to the fuel properly.

The viscosity of fire retardants is extremely difficult to estimate visually, and most viscometers capable of rendering reliable measurements are expensive and cannot be used in rough field situations.

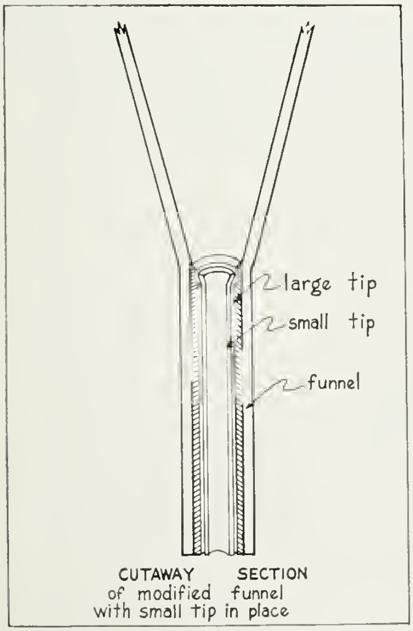


Figure 1.—Cutaway section of the modified Marsh funnel with small tip in place

To provide the measurements of viscosity needed in the field, a Marsh funnel can be modified (fig. 1) for use with all commonly used fire retardants. This funnel has a 6-inch-diameter top, and is 12 inches long. The 10-mesh screen that covers half of the top should not be used as it may change the structure of the retardant. If lumps or impurities are present, pour through screen, but delay viscosity determinations for at least 5 minutes.

Viscosity is measured by agitating the fluid, pouring it into the funnel as high as the screen, and recording the seconds necessary for 1 quart to pass through the funnel (fig. 2). Several fire-retardant materials have a much higher viscosity than that of the drilling muds for which the funnel was designed; thus, the orifice, or tip, is not large enough to accommodate these retardants. However, if the original tip is removed and replaced by a larger one, satisfactory determinations of viscosity can be made. Use of the large tip can be limited to the thicker materials, and the original one can be reinserted for measuring the thinner, less viscous materials.

METHOD OF DETERMINING VISCOSITY

There is no single correlation between calibration of the Marsh funnel and that of rotational viscometers (e.g., Brookfield) for all retardants. The two types of instruments respond differently to such characteristics as rate of gelation, gel strength, thixotropy, and density. Consequently, the Marsh funnel must be calibrated for each fire-retardant material. The following method established the relation between viscosity measured in centipoises and in "March funnel seconds":

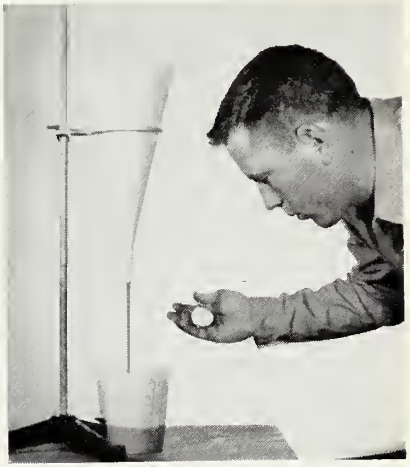


Figure 2.—Measuring viscosity with modified Marsh funnel

1. Samples of each retardant were mixed at several viscosity levels. The retardant was not touched for 15 to 18 hours after mixing.

2. A Brookfield model LVF viscometer, at 60 r.p.m. and using spindle 4 (spindle 2 for Phos-Chek 259), rendered viscosity measurements in centipoise units. The readings were taken after the spindle had turned for 1 minute in the sample.[2]

3. From the same samples we filled the Marsh funnel to the screen and measured the seconds required for 1 quart to run out the bottom into a graduated beaker. Measurements were made using both the large and small tips. Table 1 shows the relation

---

[1] The Laboratory is administered by the Intermountain Forest and Range Experiment Station, Ogden, Utah.

[2] Gelgard thinned rapidly when subjected to the revolving spindle; therefore, turning was needed for 15 seconds before reading.

TABLE 1.—*Relation of Marsh funnel time to viscosity as measured by the Brookfield model LVF viscometer at 60 r.p.m.*

[CENTIPOISES]

Time for 1 quart to flow through funnel[1]		Fire retardant								
		Gelgard M		Gelgard F		Phos-Chek		Bentonite, large tip	Fire-Trol 100	
		Large tip	Small tip	Large tip	Small tip	202, large tip	259, small tip		Large tip	Small tip
Min.	*Sec.*									
0	15	....	....	....	...	....	...	500	930	....
0	30	....	20	....	20	....	5	1,875	2,140	....
1	00	550	170	625	153	1,000	136	2,450	2,800	1,460
1	30	700	280	780	275	1,380	274	2,675	2,940	1,810
2	00	820	370	883	378	1,640	413	2,815	....	1,960
2	30	908	442	962	471	1,855	...	2,925	....	....
3	00	980	508	1,038	550	2,010	...	3,005	....	....
4	00	1,098	616	1,180	672	2,315	...	....	....	....
5	00	1,188	...	1,316	...	2,560	...	....	....	....
6	00	1,264	...	1,444	...	2,760	...	....	....	....
7	00	1,327	...	....	...	2,950	...	....	....	....
8	00	1,387	...	....	...	....	...	....	....	....

[1] Funnel must be *full* to screen before testing begins.

between viscosities measured by the Brookfield viscometer and the Marsh funnel seconds equivalents.

INSTRUCTIONS FOR MODIFICATION AND USE

A packet to help field personnel modify and use a Marsh funnel to measure viscosity is available from the Northern Forest Fire Laboratory, Forest Service, USDA, Missoula, Mont. 59801. The packet contains instructions for modification, a drawing of the modification, information on places where already modified Marsh funnels can be purchased, instructions for using table 1, and an expansion of table 1 that covers each 5 seconds through 3 minutes and each 10 seconds beyond 3 minutes.

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double spaced. The author's name, position, and organization should appear directly below the title.

Articles covering any phase of forest, brush, or range fire control work are desired. Authors are encouraged to include illustrations with their copy. These should have clear detail and tell a story. Only glossy prints or India ink line drawings can be used. Diagrams should be drawn with the page proportions in mind, and lettered so as to permit any necessary reduction. Typed captions should be attached to the illustrations, or included in the text following the paragraph in which they are first mentioned.

Prevention Program—*Continued from Page 6*

program it is particularly important to provide such training. Where men cannot devote full time to this work, other men should put as much time as possible on it. Our prevention men do a lot of complementary jobs closely related to their primary contact job. They inventory hazards and try to get them eliminated, inspect permits and uses, put up signs and posters, make group contacts, enforce rules and laws, etc. Some States are doing an outstanding job with personal contacts. Mississippi has developed a "contactors" handbook and is doing an intensive training job in such work. Results have been particularly good.

To provide better prevention some special prevention test areas deserve attention. These are management units that have had many man-caused fires. On these relatively small areas we try to do a fully adequate prevention job. We improve the financing to do what is considered needed. This is an attempt to see if fire prevention work really pays. New innovations or ideas are tried on these areas.

Results of fire prevention research are immediately applied and tested. Several such results are operational throughout the country, and we want more as quickly as we can finance them. Results to date have been good. Hopefully, ideas developed or proven successful can be extended to other areas.

Fire prevention research is really just getting well underway. However, there are many ways to improve current techniques or approaches to the phases of prevention I have listed. Much research concerning people's attitudes and reasons for starting fires is necessary. We need to go behind apparent causes and perhaps find deeper and real causes. I have long advocated each fire be thoroughly analyzed as to cause and possible prevention, just as automobile accidents and personal injuries are. This idea is still good. Also, equipment can be designed so it is less likely to start fires. There are many opportunities for building fire prevention into forest management without great cost or problems if proper consideration is given.

I could list other jobs and items that are closely connected to prevention and need to be included in a total program. By making friends and influencing people to act wisely in the forest, we are helping fire prevention. If we remove a risk or alleviate a hazard, it should help. All these efforts mean fewer fires, less firefighting, and the saving of more resources. Prevention is sure to pay if well planned and properly directed.

Projectile Launcher—*Continued from page 10*

10-yard target area; the other two ignited slash but were farther away from the desired ignition spot.

These firings were made only to determine the launcher's practicability as a technique for slash burning. No attempt was made to determine costs of the launcher or its accessories.

CONCLUSIONS

The launcher, in its present form, does not seem operational for slash burning. It seems fairly adequate for maneuverability and safe and easy handling. Its range, 300 to 400 yards, is suitable for most slash ignition use. The greatest limitation of the launcher is its lack of accuracy—a necessary requirement for effective slash ignition where fuels are concentrated but not always continuous.

Primarily, the launcher needs a rangefinder to improve accuracy. A slightly smaller bore should improve accuracy and help the projectile achieve greater velocity. A modified projectile with built-in fins would probably prevent "tumbling" in midair and further improve accuracy. Also, weight could be reduced and maneuverability improved by replacing the present pallet mounting with an adjustable tripod. And some weight might be reduced at the breach. Petroleum gels are usually quite effective as fire starters when carefully placed in a good fuel bed, but they sometimes failed to produce satisfactory ignition with the projectiles used in this test. A fuel store consisting of a napalm-type material, when detonated, might produce better fire dispersal. Although the launcher failed to meet all the objectives set forth, this test helped indicate the engineering modifications needed to make the device operational.

EDITOR'S NOTE: *A formal project to develop a projectile launcher system for igniting slash fires was started at the Missoula Equipment Development Center in 1966. A prototype system has been developed under a subsequent contract, and is being tested during the current season. Results of this project will be available at a later date.*

U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C. 20250

OFFICIAL BUSINESS

U. S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

HELITANKER PREVENTION SIGN PROVES VALUABLE

E. F. McNamara, *Chief, Division of Forest Protection*
Pennsylvania Department of Forests and Waters

Since Pennsylvania first used helitankers (in 1960), they have proven to be effective fire prevention tools. The State's entire airtanker program is based on placement of aircraft in areas of high fire occurrence. When helicopters are under contract, there is a marked reduction of fires in areas with a high rate of incendiary fires.

We have long wanted to install a high-visibility sign on the helitanker to identify it as a forest fire control unit. Such a sign would increase the fire prevention effectiveness of aircraft. However, we had to decide what type of sign was needed and how it should be secured to the helitanker.

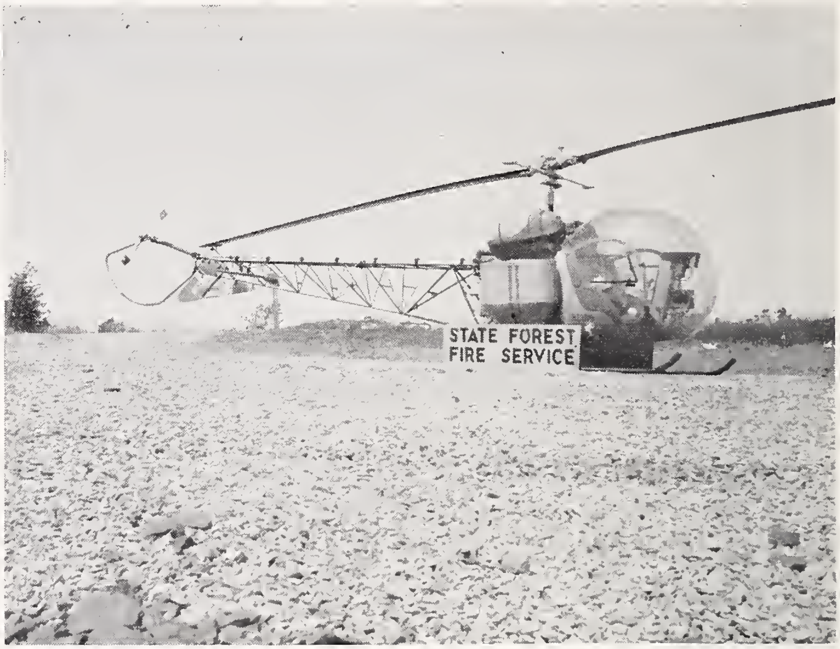


Figure 1.—This helicopter is used in Pennsylvania's fire prevention campaign.

During the 1966 fall fire season we experimented with two signs of 70 by 22 inches painted on ⅛" tempered hardboard. These signs were first painted with fluorescent international orange paint and then lettered with 7-inch black letters. The signs were secured by brackets to the skid cross members on both sides of the helicopter. The installation was approved by the FAA inspector. Both the reaction from the public and the reduction in fires in the test area convinced us that the signs were very effective in reminding people to be careful with fire in or near a forest.

During the 1967 spring season each of five Bell helitankers under contract to the Division of Forest Protection were equipped with two signs (fig. 1). Again all installations were approved by the FAA.

Constant vibration damaged the structure of the hardboard in the original pair of signs. Therefore, the 1967 signs were made of three different materials: ¼" plywood, corrugated vinyl plastic, and aluminum. The three materials will be thoroughly inspected after the 1967 contract period to determine which is the most suitable.